TECHNICAL MANUAL

INSPECTION AND REPAIR OF AIRCRAFT INTEGRAL TANKS, AND FUEL CELLS

(ATOS)

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INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

LIST OF EFFECTIVE PAGES

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

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INTRODUCTION

1. PURPOSE.

This manual establishes USAF policy for the maintenance of aircraft fuel tanks and cells. Included in this manual are general requirements for preparation of an aircraft for fuel systems and component maintenance and inspection. The requirements of this manual are applicable to all aircraft in the AF inventory. Procedures requiring special equipment, facilities or extraordinary safety precautions are not included in this manual.

2. ABBREVIATIONS.

Abbreviations used in this manual conform to AMSEY14.38M. Abbreviations appearing most frequently in this manual are as follows:

ALC	Air Logistics Centers
CCU	Climatic Control Units
ETL	Engineering Technical Letter
IPI	in-process inspection
LEL	Combustible Vapor Lower Explosive Limit
LRA	local reproduction
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
OHWG	Occupational Health Working Group
ODS	Ozone Depleting Substances
OELs	occupational exposures limits
PDM	programmed depot maintenance
RAC	Risk Assessment Code

3. GENERAL.

The manual is divided in the following chapters: Introduction; Safety Summary; Duties, Qualifications and Training; Safety, Health, and Environmental Requirements; Aircraft Fuel Systems Maintenance Facilities and Areas; Fuel Leak Evaluation, Classification, Document and Temporary Repairs; Preparation for Maintenance; Integral Tanks; Fuel Cells; Equipment and Materials; Depot Maintenance, and Glossary.

3.1 The Introduction provides authority for publication of the manual and summarizes each chapter.

3.2 The Safety Summary details the significance and use of WARNING, CAUTION and NOTES.

3.3 Chapter 1 summarizes the duties, qualifications and training for personnel and organizations involved in fuel systems repair, and provides for resolution when the requirements of this manual conflict with other Air Force documents.

3.4 Chapter 2 provides safety, health, and environmental requirements necessary to perform fuel systems repair.

3.5 Chapter 3 provides a brief description of the areas and facilities required for fuel systems maintenance. This includes Category I, II, and III facilities, and open areas.

3.6 Chapter 4 provides information for categorizing fuel leaks, documenting leaks in the aircraft records, and applying temporary repairs to aircraft fuel leaks.

3.7 Chapter 5 provides instructions preparing an aircraft for maintenance. Included are procedures for fluid purge, air purge, inerting, ventilating open tanks, draining, and depuddling aircraft. Removal inspection and replacement of fuel foam is included in this chapter.

3.8 Chapter 6 describes the various techniques for inspecting and repairing integral tanks. Procedures common to all levels of maintenance or not requiring special facilities or extraordinary safety precautions are detailed. Procedures requiring special equipment, facilities or extraordinary safety precautions are not included in this manual.

3.9 Chapter 7 describes the various techniques for inspecting and repairing fuel cells.

3.10 Chapter 8 lists the equipment and material necessary to perform the inspection and repair procedures described in this manual.

3.11 Chapter 9 provides information for depot maintenance.

3.12 Glossary contains definitions of both common words and words/phrases peculiar to fuel systems repair.

SAFETY SUMMARY

1. GENERAL SAFETY INSTRUCTION.

This manual describes physical and chemical processes which may cause injury or death to personnel, or damage to equipment if not properly followed. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment. Prior to performing any task, the WARNINGs, CAUTIONs and NOTEs included in that task shall be reviewed and understood.

2. WARNINGS, CAUTIONS AND NOTES.

WARNINGs and CAUTIONs are used in this manual to highlight operating or maintenance procedures, practices, conditions or statements which are considered essential to protection of personnel (WARNING) or equipment (CAUTION). WARNINGs and CAUTIONs immediately precede the step or procedure to which they apply. WARNINGs and CAUTIONs consist of four parts: heading (WARNING, CAUTION or Icon [see HAZARDOUS MATERIALS WARNINGS]), a statement of the hazard, minimum precautions, and possible result if disregarded. NOTEs are used in this manual to highlight operating or maintenance procedures, practices, conditions or statements which are not essential to protection of personnel or equipment. NOTEs may precede or follow the step or procedure, depending upon the information to be highlighted. The headings used and their definitions are as follows:

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

CHAPTER 1
DUTIES, QUALIFICATIONS AND TRAINING

1.1 REPAIR RESPONSIBILITY.

Field level maintenance organizations shall be responsible for accomplishing normal fuel tank maintenance and repair. If specialized personnel and/or equipment and facilities are required but are not available at the organizational level, assistance shall be requested from the appropriate area support ALC in accordance with TO 00-25-107, MAJCOM functional managers, the Weapon System Manager and the OPR for this technical order.

1.2 AUTHORITY.

The provisions of this manual are directive in nature and are applicable to all military and civilian personnel directly or indirectly concerned with fuel systems maintenance In addition to the requirements of this manual, civilian contractors are responsible for meeting the requirements of the applicable National Fire Protection Association (NFPA) and Occupational Safety and Health Administration (OSHA), in addition to other laws (federal, state, and local). AFOSH 91-100 provides authority for this manual to contain safety and health requirements for: fuel cell/tank maintenance, fuel system maintenance, fuel system repair facilities, and related areas.

1.2.1 The word SHALL means that the requirement is mandatory.

1.2.2 The word WILL is used to express declaration of purpose.

1.2.3 The word SHOULD is used to express a non-mandantory desire or preferred method of accomplishment.

1.2.4 The word MAY is used to express an acceptable means of accomplishment.

1.3 CONFLICT.

Every attempt is made to keep this manual current with all safety, health and environmental directives. When this manual is in conflict with an AFOSH, OSHA or other federal directive an AFTO 22 shall be submitted in accordance with TO 00-5-1. When the requirements of this manual are in conflict with state or local directives resolution shall be sought through that agency with assistance from the MAJCOM functional manager for fuel systems. When this manual conflicts with other general series or policy and procedures technical orders the requirements of this manual should take precedence. When this manual conflicts weapon system or commodity technical orders the requirements of the weapon system or commodity technical order take precedence for all non-safety, non-health, and non-facility related issues.

1.3.1 The general safety and health and maintenance procedures of this manual can be applied to removable metal tanks, Benson, ferry and external removable/jettisonable tanks. Specific procedures for these types of tanks are generally included in the commodity TO for the tank. Repair of oil, water, and alcohol integral tanks and cells can be performed using the requirements and procedures of this manual.

1.4 PERSONNEL.

Information concerning the responsibilities, qualifications and training requirements of this manual are summarized in the following paragraphs. This is provided for informational purposed only; for complete requirements refer to the text of this technical order.

1.4.1 As the Air Force reorganizes various individual's functions change as do their duty titles. The most common or accepted position titles are provided for military and civil service members of the Department of the Air Force. Contractors performing work to the requirements of this manual are expected to meet the same requirements of their Department of the Air Force counterparts. Table 1-1 is provided as guidance to determining Civil Service equivalents at Air Logistics Centers to military positions:

Table 1-1. Position Equivalents

Military	Civil Service
Logistics Group Commander (MXG/CC,LG/CC), Deputy Commander Maintenance (DCM), Maintenance Group Commander (MG/CC) AFSC 2A6X4 AFSC 454X3	Production Division Chief for each Directorate WG-4361-XX or WG-8801-XX or WG-8852-XX or WG-8268-XX or Other WG Series as designated by local management
Fuel Section Chief	First Level Fuel Shop
Fuel Shop Chief	Supervisor

1.4.2 The responsibilities, qualifications and training requirements for all personnel directly or indirectly responsible for fuel systems maintenance are as follows: This is provided for informational purposed only; for complete requirements refer to the text of this technical order.

1.4.2.1 LG/CC - MXG/CC - Production Division Chief.

1.4.2.1.1 Responsibilities.

a. Shall appoint an Entry Authority (usually Fuels Section Chief).

b. Shall be responsible for all fuel tank/cell entries.

c. Shall sign the Master Entry Permit.

d. Shall designate open fuel system repair areas as necessary.

e. Shall ensure technical orders and/or operating instructions (as applicable) for equipment used in fuel system repair areas and facilities are available and followed.

f. Shall ensure all safety, health, and environmental regulations are complied with.

g. Should coordinate on material and equipment substitutions.

h. May, when authorized substitute non-2A6X4 personnel for attendant.

i. May, when authorized coordinate on wavier of certain safety and health requirements.

1.4.2.2 Entry Authority/Alternate Entry Authority. In the absence of or when otherwise authorized by the Entry Authority the Alternate Entry Authority will perform the duties of the Entry Authority.

1.4.2.2.1 Responsibilities.

a. Shall complete and sign each Entry Permit.

b. Shall designate an Alternate Entry Authority.

c. Shall designate a fuel tank entry chief.

d. Shall ensure entries are conducted using safety practices and procedures of this manual.

e. Shall ensure entrants are qualified.

f. Shall ensure attendants are qualified and available.

g. Shall ensure the equipment monitor/runner is trained and available when required.

h. Shall assist in developing severe weather shutdown plan.

i. Shall provide guidance on PPE for all entries.

j. Shall assist in developing rescue plan.

k. Shall never permit entry into an IDLH atmosphere.

l. Shall establish a system for controlling tank entries.

m. Shall only issue entry permits when conditions of Master Entry Permit are met. Will amend or reissue entry permit as necessary.

n. Will help develop training plans for fuel tank entries.

o. May authorize attendant to monitor multiple tanks.

p. May eliminate equipment monitor/runner in selected circumstances.

1.4.2.3 Entrant (2A6X4 or civilian equivalent).

1.4.2.3.1 Responsibilities.

a. Shall be responsible for complying with entry permit.

b. Shall obey instructions from attendant.

1.4.2.4 Entrant (non-2A6X4 or civilian equivalent).

1.4.2.4.1 Responsibilities.

a. Shall be responsible for complying with entry permit.

b. Shall obey instructions from attendant.

1.4.2.5 Attendant.

1.4.2.5.1 Responsibilities.

a. Shall have overall responsibility for monitoring the entry area.

b. Shall alert equipment monitor/runner prior to initiating rescue.

c. Shall limit entry to those authorized.

d. Shall order evacuation of tank as necessary.

e. May, when authorized, monitor multiple tanks.

f. May be part of rescue team.

1.4.2.6 Equipment Monitor/Runner.

1.4.2.6.1 Responsibilities.

a. Shall summon rescue team when required.

b. Shall monitor equipment.

c. Shall remain in immediate area.

d. Shall initiate rescue procedures when required.

e. May perform duties of attendant during rescue.

f. May monitor multiple tanks or aircraft.

g. May be part of rescue team.

h. May enter tank if qualified.

1.4.2.7 Rescue Team - Extraction Team..

1.4.2.7.1 Responsibilities.

a. Extract entrant from tank.

b. Administer buddy care.

Table 1-2. Summary of Qualifications and Training for confined Space Entry Personnel

	ENTRY * AUTHORITY	ENTRANT * 2A6X4	ENTRANT * NON 2A6X4	ATTENDANT	EQUIPMENT * MONITOR
CPR	X	X		X	
MEDICAL	X	X	X	X	
RESPIRATOR (Qualified)	X	X	X		
TESTING CONFINED SPACES (Atmosphere)	X	X		X	
SELF AID/BUDDY CARE	X	X			
HAZARD COMMUNICATION	X	X	X		
TANK FAMILIARZATION	X	X	X	X	
SELF RESCUE	X	X	X		
CONFINED SPACE HAZARDS	X	X	X	X	X
RESCUE PLAN	X	X	X	X	X
USE OF SHOP EQUIPMENT	X	X			X
USE OF RESPIRATORS	X	X	X	X	
USE OF OTHER PPE	X	X	X		
USE OF COMMUNICATIONS EQUIPMENT	X	X	X		
R ECOGNIZING EXPOSURE TO CHEMICALS, SOLVENTS, AND FUELS	X	X	X	X	

NOTE

This table applies to field maintenance only. At Depot level the Fire Department will be the Emergency Response Team. All personnel on the rescue team shall be qualified and capable of safe entry and egress from the fuel tank/cell. This will allow and ensure safe extraction in case of an emergency.

1.4.2.8 <u>Fuels Section Chief - First Level Supervisor</u>.

1.4.2.8.1 <u>Responsibilities</u>.

a. Shall assist in developing rescue plan.

b. Shall implement severe weather shut-down plan.

c. Shall ensure safety, health, and environmental directives are complied with.

d. Will usually be the entry authority.

e. Shall coordinate all fuel tank/cell entries at field level.

1.4.2.9 Quality Assurance. Quality control personnel who will perform evaluations shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief. The local training shall cover safety equipment, grounding, bonding, purging procedures, and depuddling operations. Training or recertification shall be conducted annually.

1.4.2.9.1 Responsibilities. Provides task evaluation and ensures compliance with T.O. 1-1-3.

1.4.2.10 Ground Safety Office.

1.4.2.10.1 Responsibilities.

a. Should provide training on subject matter for which they have expertise.

b. Shall assist in developing rescue plan.

c. Shall coordinate on Master Entry Permit.

d. Coordinate on equipment substitutions.

e. Shall coordinate on approval of open fuel system repair areas.

f. Shall coordinate on approval of temporary fuel system repair areas.

1.4.2.11 Bioenvironmental Engineering Flight (BEF) Office.

1.4.2.11.1 Responsibilities.

a. Should provide training on subject matter for which they have expertise.

b. Shall coordinate on Master Entry Permit.

c. Should conduct periodic sampling to measure toxins.

d. Shall provide guidance on PPE used for entries.

1.4.2.12 Environmental Management Office.

1.4.2.12.1 Responsibilities. Should provide training on subject matter for which they have expertise.

1.4.2.13 Fire Department.

1.4.2.13.1 Responsibilities.

a. Should provide training on subject matter for which they have expertise.

NOTE

These topics include but are not limited to: use and positioning of fire extinguishers, theory of combustion and NFPA codes. The fire department's capabilities should be an integral part of the rescue plan but not be listed as the initial response agency for emergencies. Except at Depot where the Fire Department will be the initial Response Agency for emergencies.

b. Shall coordinate on Master Entry Permit

c. Should assist in developing rescue plan.

d. Shall coordinate on approval of open fuel system repair and temporary areas.

1.4.2.14 Base Medical Officer.

1.4.2.14.1 Responsibilities.

a. Should assist in developing rescue plan.

b. Shall perform medical examinations in accordance with AFOSH standards.

c. Should provide training on subject matter for which they have expertise.

1.4.2.15 System Program Manager - System Program Office.

1.4.2.15.1 Responsibilities.

a. Shall keep Technical Orders current.

b. Shall provide assistance to field and depot level maintenance activities.

c. May approve the use of alternate equipment.

d. May approve the use of alternate materials.

e. Should coordinate equipment and material substitution with the MAJCOM functional manager and OPR for T.O. 1-1-3.

1.4.2.16 Base Weather Officer.

1.4.2.16.1 Responsibilities. Shall assist in developing severe weather shutdown plan.

1.4.2.17 Major Command Functional Manager.

1.4.2.17.1 Responsibilities.

a. Should provide assistance to field and depot level maintenance activities.

b. May approve the use of alternate equipment.

c. May approve the use of alternate materials.

d. Should coordinate equipment and material substitution with the SPM and OPR for T.O. 1-1-3.

1.4.2.18 Office of Primary Responsibility for T.O. 1-1-3.

1.4.2.18.1 Responsibilities.

a. Shall keep this technical order current with applicable safety and health directives.

b. Should provide assistance to field, depot and contractor maintenance activities.

c. Say approve the use of alternate equipment.

d. Say approve the use of alternate materials.

e. Should coordinate equipment and material substitution with the MAJCOM functional manager and SPMs.

CHAPTER 2
SAFETY, HEALTH, AND ENVIRONMENTAL REQUIREMENTS

2.1 PURPOSE.

This chapter contains the safety, health, and environmental requirements necessary to conduct fuel systems maintenance with special emphasis on the requirements for tank and cell maintenance. This chapter covers personnel, facilities, equipment, and aircraft.

2.2 GENERAL.

2.2.1 The provisions of this chapter are minimum requirements for average conditions. These provisions apply to fuel systems repair personnel and non-fuel systems repair personnel (for example: electricians, safety, and supervisory personnel). The requirements of this chapter assume a single aircraft is in the facility. For guidance on working more than one aircraft contact the appropriate base agencies, e.g. MXG, LG/CC, fire department, and ground safety.

2.2.2 Certain hazards are present during fuel systems maintenance. The presence of hazards is normal and if precautionary measures are taken there will be no increased risk associated with the maintenance operations. Cooperation is required from all personnel to cope with conditions presented. Deviations shall not be permitted from safety practices which increase the risk to the worker, aircraft or facility. Supervisory personnel shall make sure all equipment is maintained in good working order and that personnel adhere to the requirements of this chapter.

2.2.3 Training Requirements.

2.2.3.1 Mishaps do not happen. Mishaps are caused by deviation from accepted practice, thus, mishaps are preventable. Proper safety instruction and training are essential to an accident free work environment.

2.2.3.2 All personnel (fuel and non-fuel) engaged in activities outlined in this manual shall be fully trained in the following (in addition to the training required for specific duties, e.g., attendant, emergency response team):

a. Hazardous characteristics of the materials being used.

b. Hazard communications.

c. Use and limitations of the equipment being used.

d. Fuel system/tank familiarization.

e. Use of personal protective equipment.

f. How to protect personnel, aircraft, equipment and the environment from hazards encountered.

2.2.3.3 Training and certification are required prior to permitting an employee to enter a tank/cell. Training and recertification shall be accomplished annually and in accordance with MAJCOM directives.

2.2.3.4 Associated maintenance shops shall have a sufficient core of trained personnel (that are confined space entry qualified) to meet work requirements with minimal delay.

2.2.3.5 Quality Assurance personnel who will perform evaluations shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief. The local training shall cover safety, equipment, grounding, bonding, purging procedures, and depuddling operations. Training or recertification shall be conducted annually.

2.2.3.6 Training will be provided by qualified individuals. Lesson plans or training outlines shall be approved by the responsible MXG/CC, LG/CC, Safety Office, BEF, Fire Department, and Environmental Management office as applicable.

2.3 ASSUMPTIONS AND ALTERNATIVES.

Some fuel cell/tank inspection and maintenance is accomplished without fuel or other flammable materials being present. In these cases the MXG/CC or LG/CC may, with coordination and concurrence from ground safety, BEF, and the fire department, rule that certain requirements of this chapter may be waived (the requirement for a permit entry system shall not be waived). This may be done after a review of the work procedures, an assessment of the work environment, and documentation of the absence of presumed hazards. The waiver is only applicable to requirements originating in this manual and is not extendible to requirements originating in weapon system technical orders, OSHA documents, and AFOSH documents.

2.4 HAZARDS PRESENT.

2.4.1 Static Electricity. Static electricity is frequently generated when two unlike materials are brought into contact and then separated. Some common means of generating static charges are; a person removing clothing, dust blowing across a surface, or liquid flowing through a pipe. The most practical method to protect against static charge buildup is to dissipate the static charges through proper connections to the ground. All personnel approaching an aircraft for fuel systems maintenance shall touch a static discharge plate or grounding point to remove static electricity.

2.4.2 Confined Spaces and Enclosed Areas.

2.4.2.1 Confined spaces create a unique hazard due to limited entry/exit points and potential atmospheric hazards. To limit the risk associated with entry the confined space shall be assessed for hazards. Entry to the space shall be limited to authorized individuals and rescue procedures shall be in place prior to any entry. To prevent accidental death or injury from entrapment in confined spaces the requirements of this chapter and the applicable AFOSH standards shall be followed (91 and 48 series).

NOTE

All personnel assigned to a fuel system repair chapter shall be qualified to enter the smallest fuel tank/cell that permits personnel entry on all MDS assigned.

2.4.2.2 Some aircraft have tanks which are separated into multiple compartments. For the purposes of this T.O. each compartment will be treated as an individual tank. When air purging each compartment will be purged and depuddled, to the extent necessary, before opening the next compartment.

2.4.3 Hot Work. Hot work (e.g. cutting, welding, soldering, or any other operation that can provide a possible source of ignition) will generate temperatures high enough to ignite fuel, solvents, and other materials present during fuel systems repair. Special care must be taken to eliminate the combustion hazard associated with hot work. Approval for hot work in confined spaces shall be obtained from the base fire department. To prevent accidental death, injury or damage to aircraft the requirements of this manual and applicable AFOSH standards shall be followed.

2.4.4 Chemicals. Solvents, chemicals, and other products used to repair aircraft fuel tanks and cells may be classified as flammable or combustible depending on their flash point. In addition to the fire hazard these solvents, chemicals, and products may contain toxic substances. To prevent ignition of, or overexposure to, these products the requirements of this chapter and the applicable AFOSH standards shall be followed (91 and 48 series). A Material Safety Data Sheet (MSDS) shall be available for each solvent, chemical or product used. Manufacturer's warnings and cautions shall be observed. Contact the local BEF for guidance on personal protective equipment to be used when working with solvents, chemicals, and other products.

2.4.5 Radar and Communications Systems. Certain radar and communications systems, especially high powered ground based systems, are capable of producing peak power densities intense enough to cause unintentional ignition of volatile fuels when used in close proximity to fuel servicing, storage or maintenance areas. The base communication officer shall be contacted periodically to determine if equipment capable of producing such intensities is presently being used or future use is planned. Guidelines for separation distances are contained in TO 31Z-10-4. Assistance may be requested from the local BEF office (OPR for radio frequency radiation program).

2.4.6 Fuels.

2.4.6.1 Air Force aircraft fuels are classified as either combustible or flammable liquids. AVGAS and JP-4 have a large percentage of low flash point hydrocarbons and will create a readily ignitable vapor-air concentration at ambient temperatures. AVGAS and JP-4 are flammable liquids. JP-5 and JP-8 are comprised of a larger percentage of higher flash point hydrocarbons and do not as readily form flammable vapor-air concentrations at ambient temperatures. JP-5 and JP-8 are combustible liquids. At temperatures below the flash point fuels are not likely to generate sufficient vapors to form a vapor-air concentration in the explosive range. Military Specification fuels (JP-Series) require the use of antistatic additives. Commercial fuels (Jet-A, Jet-A1, Jet-B) do not have antistatic additives.

The values of Table 2-1 are approximate since the fuels have a flashpoint range. JP-5 and JP-8 flashpoint are the specification minimums.

Table 2-1. Common Jet Fuel Properties and Additives

JET FUEL PROPERTIES					
	JP-4	JP-8	JET A-1	JET A	JP-5
FLASHPOINT °F	-20	100	100	100	140
FREEZE POINT °F	-72	-53	-53	-40	-51
FLAMM °F	-20 TO 80	100 - 170	100 - 170	100 - 170	140 - 220
LBS/GAL	6.3	6.7	6.7	6.7	6.8
VAPOR PRESSURE	2-3	NIL	NIL	NIL	NIL
AROMATICS %	25	25	20	20	25
BTU/GAL (TYPICAL)	118900	124500 (+4.7%)	124500	124500	126000 (+5.9%)
JET FUEL ADDITIVES					
	JP-4	JP-8	JET A-1	JET A	JP-5
FSII	YES	YES	NO*	NO*	YES
CORR/LUBR	YES	YES	NO*	NO*	YES
CONDUTIVITY	YES	YES	YES	NO*	NO
ANTI-OXIDANT	COND	COND	NO*	NO*	YES
METAL DETACT	OPT	OPT	NO*	NO*	OPT
TRACER	OPT	OPT	NO	NO	OPT
COND = IF HYDRO TREATED					
OPT = OPTION OF SUPPLIER					
* = APPROVED BUT NOT TYPICALLY USED					

FUEL TYPE	FLASHPOINT	PPM (LEL) AVGAS	-50°F
14,00 JP-4	-20°F	8,000 JP-5	140°F
6,000 JP-8	100°F	7,000 JP-10	127°F
6,500 JPTS	109°F	6,100	

2.4.6.2 In addition to the fire hazard, fuels also contain toxic substances such as benzene; toluene and xylene. Exposure to high levels of fuel may cause headaches, dizziness, or euphoria. Dermal exposure might result in itchy, red, peeling or tender skin. To prevent ignition of or overexposure to aircraft fuel the requirements of this chapter and the applicable AFOSH standards shall be followed (91 and 48 series).

2.4.7 Climatic Conditions. High winds (usually 30 kts/hr or higher), thunderstorms/lightning or other forms of severe weather can damage aircraft or injure personnel. Severe weather can cause power outages, create a hazard from wind blown materials, sand or equipment, create high levels of static electricity, cause water intrusion or cause other problems. Lightning may cause the ignition of fuel vapors or electrocution of personnel. Extremes in temperature can cause heat stress, freezing of skin and other injuries or illnesses. For guidance on performing fuel systems maintenance during periods of temperature extremes contact the local BEF office.

2.4.8 Environmental Hazards. Many of the operations in this manual use materials which generate hazardous waste or can damage the environment. Many of the solvents including those claiming to be biodegradable are capable of generating significant amounts of hazardous waste. The use of Ozone Depleting Substances (ODS) is being banned. Every effort has been made to eliminate the use of ozone depleting substances to the maximum extent possible. Ozone depleting substances may only be used when no other alternative is available and then approval must be granted in accordance with Air Force policy. The local Environmental Management Office should be contacted for further information and guidance on this subject.

2.4.9 Ancillary Systems. Fire Suppression Systems, OBIGGS, and hydrazine systems require extreme caution. Refer to applicable aircraft technical manuals for more specific guidance.

2.5 MEDICAL REQUIREMENTS.

2.5.1 Physical Examinations. The design, development and execution of USAF employee health programs are described in AFI 48-145, Occupational Health Program. Specific medical surveillance requirements for fuels systems personnel are defined in AFOSH Standard 48-8, Controlling Exposures to Hazardous Materials. In accordance with AFI 48-145, the base level Occupational Health Working Group (OHWG) may add to the 48-8 requirements based on a comprehensive review of the exposure risk and medical literature. However, the medical surveillance requirements addressed in the 48-8 should be considered the minimum requirement to make sure worker health and safety. Personnel who are required to wear respirators must be evaluated prior to fit testing as required by AFOSH Std 48-137, Respiratory Protection Program.

2.5.2 Medical Treatment.

2.5.2.1 If a worker's eyes are exposed to fuel, the eyes must be flushed immediately and repeatedly with fresh water. Medical treatment shall be obtained as soon as possible. If a worker's skin is exposed to fuel, the skin must be thoroughly cleansed of any fuel with mild soap and water, as soon as possible. Medical attention shall be obtained if abnormal conditions or symptoms develop. Regardless of prior cleansing, any worker who has direct contact with fuel (e.g. wet fuel operations) must shower at the end of the shift.

2.5.2.2 Personnel ingesting fuel or other chemicals shall be immediately taken to a medical facility for treatment. Do not induce vomiting unless authorized by medical personnel.

2.5.2.3 For treatment of other types of injury and illness contact base medical officer.

2.6 PROTECTIVE CLOTHING AND EQUIPMENT.

2.6.1 Clothing.

2.6.1.1 Coveralls. Personnel performing fuel maintenance in fuel systems repair areas/facilities shall wear approved coveralls to protect them from fuel exposure while eliminating the possibility of creating a static electricity discharge. The coverall material must be static-resistant and buttons or tabs must be non-sparking. The coveralls must offer adequate protection from liquid penetration without a significant increase in heat stress levels. The tri-layer coverall shall be worn for operations that involve direct prolonged exposure, including wet fuel operations such as fuel tank entry, foam removal/installation and depuddling (e.g., A-10, C130 and F-15). The Tri-Layer coveralls shall be worn at all times during fuel tank operations except when the tank has been completely depuddled, dried and ventilated with no chance of seepage of fuel from other areas such as fuel lines (99.9% of the time this will be at Depot only). Standard cotton coveralls are acceptable for other applications that do not generally have direct contact with fuel. All coveralls will be thoroughly washed after use. Personnel shall not wear coveralls that are dirty, soiled, or have any residue. Coveralls with excessive dried sealant or stains will be discarded. Care should be taken to make sure loose buttons do not snag on fuel system components and become torn loose.

2.6.1.2 Chemical Resistant Clothing. Personnel may use additional chemical resistant clothing if approved by the base bio-environmental office. This clothing will be covered by approved outer garments to prevent discharge of static electricity. In general this clothing will increase the probability of heat stress.

2.6.1.3 Footwear. Personnel entering the fuel systems repair areas/facilities shall remove all footwear with exposed spark producing nails or metal plates on the walking surfaces. Clean shoes or boots with or without footwear covers may be worn in integral tanks. Shoes or boots shall not be worn in bladders. Static-resistant booties or neoprene shall be worn. Cotton or cotton blend socks with or without footwear covers are optional. make sure the booties are clean and serviceable.

2.6.1.4 Gloves. Chemical resistant gloves or other locally approved gloves are required for depuddling fuel, application of cleaners/solvents, and removal of explosion suppression foam. Static-resistant, chemical resistant gloves must also be worn for the application of sealants and adhesives. Hand creams and barrier creams, are not considered suitable hand protection but may be used under any approved glove.

2.6.1.5 Head coverings. Head coverings must be worn whenever a potential exposure to liquid fuel (e.g., pulling foam overhead) exists. The head covering must be chemical and static resistant. Head coverings must also be worn when accomplishing internal curing type sealant repair. The head covering will prevent scalp oils from contaminating aircraft surfaces and minimize the possibility of getting sealant in hair.

2.6.1.6 Knee and Elbow Pads. Neoprene rubber knee and elbow pads may be used for protection. Neoprene rubber mats may be laid in the cell/tank for cushioning and protection.

2.6.2 Personal Protective Equipment.

2.6.2.1 Respirators. The local BEF and the Entry Authority shall provide guidance on respiratory protection. A full-face supplied air respirator shall be worn for all fuel cell/tank entries. All respirators shall be selected and maintained in accordance with AFOSH 48-137. Entry Authority/Supervisor will make sure the selected respirator's NIOSH certification is maintained, and the air pump pressure supplied to respirator meets respirator manufacturer's requirements. If organic vapor cartridges are used, they must be changed out according to a locally determined change out schedule determined by the BEF.

2.6.2.2 Eye Protection. Personnel performing work that has the potential to irritate the eyes or expose the eyes to liquids, dusts, flying objects, etc., shall wear appropriate eye protection (i.e., goggles) if a full-face respirator is not required. Contact lenses can be worn in conjunction with protective eyewear.

2.6.2.3 Hearing Protection. The local BEF shall determine hearing protection requirements based on a survey of operations performed.

2.6.3 Monitoring Equipment.

2.6.3.1 JP-8 Vapor Meter. JP-8 vapor concentration must be measured using a photoionization detector (PID). A PID uses an ultraviolet lamp to ionize vapor molecules. A PID measures JP-8 vapor in parts per million (ppm), not % LEL. An equivalent meter must be approved/coordinated with the item manager, equipment specialist, MAJCOM Fuel Systems Representatives, AFIERA/RSHI, and the manager of this T.O.

2.6.3.1.1 PID Measurements. A PID measures in parts per million (ppm). A conservative estimate of JP-8 LEL is 0.6% or 6,000 ppm. The concentration of JP-8 vapor must be below 600 ppm (10% LEL of JP-8) before tank entry is authorized.

2.6.3.1.2 PID Operations. The PID should be calibrated with nonane or a JP-8 gas surrogate. The ultraviolet lamp should be 10.2-10.6 eV.

NOTE

The JP-8 LEL of 0.6% is specific to JP-8. Other fuels and gases will have different LEL values.

2.6.3.2 Oxygen Meter. This meter may be combined with the PID. The oxygen meter should be capable of measuring oxygen concentrations in the 4 percent to 25 percent range.

2.6.3.3 Some PIDs have both oxygen and JP-8 vapor measurement capability. These meters must meet the same general detection capability as the stand-alone equipment.

2.6.3.4 Toxicity Indicators. In general instrumentation designed to detect toxic chemicals is not required for day-to-day fuel systems maintenance. The local BEF should conduct periodic sampling to detect and measure toxic substances.

2.6.4 Emergency Rescue and Retrieval Equipment.

2.6.4.1 Respirator. A full face, supplied air, respirator and all associated interconnects shall be maintained at the work site to use in emergencies. The Fuels Section Chief and BEF should select emergency escape respirators using the guidance in AFOSH 48-137. (Except at Depot level where the Fire Department will be the initial Response Agency and will supply all rescue equipment required).

2.6.4.2 Lifting and Retrieval Devices. These devices are used to assist in removing incapacitated personnel from tanks. These devices can damage the aircraft or further injure personnel if improperly designed or used (reference AFOSH 91-46). Approval for use of these types of equipment requires the fuel system element chief obtain coordination/approval from the Aircraft System Program Manager (SPM)/ Engineering, Fire Department, Ground Safety Office.

2.6.4.3 Other equipment, if required, shall be approved by the System Program Director, Fire Department, Ground Safety office, fuel element shop chief, and BEF as necessary.

2.7 SAFETY PRACTICES.

2.7.1 Support Equipment.

2.7.1.1 General. All rolling support equipment used in fuel systems repair areas/facilities shall be equipped with anti-static, non-metal, (rubber or composition) wheels. Equipment shall be inspected prior to being brought into the fuel systems repair area/facility. Fire extinguishers, sealant guns, mixers, communications equipment, aircraft jacks, and other similar equipment are not considered support equipment. Support equipment shall be inventoried or controlled to make sure none is left on or in the aircraft during fueling, defueling or flight.

2.7.2 Powered Support Equipment. Powered support equipment shall bepositioned outside the 50 foot marked area. Equipment should be positioned upwind if possible to guard against possible ignition sources. All support equipment shall have cables and hydraulic lines in excess of 50 feet. Exceptions are the MA-1 blower, HDU-13/M heater, explosion proof fans/blowers, Air Purifier Cart, or any other explosion proof/intrinsically safe equipment which are allowed within the marked area. Equipment within the marked area shall be bonded to the aircraft. Equipment outside the marked area does not require grounding or bonding. Ambient air breathing equipment shall be positioned away from vehicle/equipment exhaust, ventilating/ purging exhaust ducts or other similar operations to make sure air intakes are located in an uncontaminated area.

2.7.3 Non-Powered Support Equipment. Work Stands. Personnel are subject to falling when working above floor level. Workstands shall be provided, used and maintained in accordance with applicable directives. Work stands shall have nonslip step surfaces. Worn step surfaces shall be repaired or replaced. Work stands shall have static discharge plates and bonding wires as required by paragraph 2.9.5.

2.7.4 Tools and Tool Boxes.

2.7.4.1 Rubber wheeled, maxi-type toolboxes are authorized inside fuel systems repair facilities and areas without being grounded or bonded. All hand carried tool boxes brought into the fuel systems repair facility/area shall be placed on a non-metal, antistatic composition or rubber mat. At no time shall the box be placed on another surface or carried onto the aircraft or work stands. Tools required to perform maintenance shall be hand carried to the aircraft in non-metallic containers, such as fiberboard boxes or canvas bags. Toolboxes locked and secured in storage racks need not be removed from the fuel systems repair facility provided they remain locked in the storage rack.

2.7.5 Fuel Collection Containers. Fuel shall only be collected in approved safety containers, bowsers, or rubber pails. All containers should be marked to denote grade of fuel contained. Bowsers and metallic safety containers shall be bonded to the aircraft during fuel transfer. Locally manufactured containers shall meet the requirements of TO 00-25-172. Drip pans are not approved fuel collection containers. Fuels without antistatic additives shall not be allowed to free-fall into any container unless absolutely necessary (free-fall shall be kept to the minimum necessary). All pails and drip pans shall be emptied daily or more often as necessary.

2.7.6 Electrical Equipment.

2.7.6.1 Aircraft Radar. Separation distances between fuel systems repair areas/facilities and aircraft radar should be provided in the systems technical orders. If the system technical order is not available or do not contain separation distances then 300 feet (100 feet when using a dummy load) is the required minimum distance. Refer to TO 31Z-10-4 for additional information.

2.7.6.2 Radios. Mobile radios may be used in fuel systems repair areas/facilities for communication between job control and the fuel system work center or for emergency communication. Restrictions of TO 31Z-10-4 shall apply.

2.7.6.3 Non-intrinsically safe radios shall be kept at least 50 feet away. The distance requirements do not apply to adjacent offices that are enclosed.

2.7.6.4 Intercoms, Radios, and Telephones. Intrinsically safe radios/intercoms or telephones approved for NFPA 70 Class I, hazardous areas may be used. Intercoms, radios, and telephones are permitted in fuel systems repair areas/facilities to maintain communications between members of the entry team or other personnel. These items shall be maintained, inspected, and repaired in accordance with manufacturer's instructions.

2.7.6.5 Flashlights. Flashlights used in fuel systems repair areas/facilities shall be intrinsically safe or approved for NFPA 70 Class I, hazardous areas. Flashlights shall be checked for serviceability prior to use. As a minimum the flashlight shall have an unbroken lens, no missing seals or other visible defects.

2.7.6.6 Lights. All lights other than flashlights used for, or in, fuel systems repair areas/facilities shall be approved for NFPA 70 Class I, hazardous areas (explosion-proof type).

2.7.6.7 Other Electrical Equipment (i.e. digital cameras and PMA's). All other electrical equipment used in fuel systems repair areas/facilities shall be either intrinsically safe or approved for NFPA 70 Class I, hazardous areas. In the event non-intrinsically safe or non-NFPA 70, Class I, approved equipment must be used, the tank shall be purged to 1.5% LEL or less and continuously air purged and monitored.

2.7.7 Communications and Visual Aids.

2.7.7.1 Communication. Voice or visual signal communications are essential to maintaining a safe working environment. Communication shall be maintained between all personnel present. The use of an approved radio, intercom, or telephone is recommended. Personnel shall be briefed on visual signals prior to each entry.

2.7.7.2 Streamers and Forms.

a. All support equipment, plugs, caps, and cover plates connected to the aircraft shall have a red ''REMOVE BEFORE FLIGHT'' streamer. The red streamer will be attached at the point where the equipment is connected to the aircraft. AF Form 1492 shall not be used in lieu of red streamers.

b. All vent plugs, vent caps, vent cover plates, and equipment that will affect the venting, fueling, defueling, or transferring of fuel on an aircraft shall have a yellow ''REMOVE BEFORE FUELING/DEFUELING'' streamer. If yellow streamers are not available AF Form 1492 (WARNING TAG) shall be used for each vent plug installed on the aircraft. The AF Form shall be attached to the single point refueling receptacle along with an AFTO Form 781A entry of location of plug. Yellow streamers can be locally manufactured and should be 2 to 3 feet long.

NOTE

Severe aircraft structural damage can be cause by failure to remove plug and caps from aircraft vent system.

c. An in-process inspection (IPI) shall be accomplished prior to all tank/cell closures to minimize FOD hazard and make sure all materials, tools and equipment taken into the tank/cells are removed. The IPI shall be documented in the aircraft's 781A forms.

2.7.7.3 Signs. All fuel systems repair areas/facilities shall be clearly marked with warning signs ''DANGER, OPEN FUEL TANKS, UNAUTHORIZED PERSONNEL KEEP OUT''. All Category I facilities shall also have ''NO FUELED AIRCRAFT IN THIS FACILITY'', signs posted in the aircraft maintenance area.

2.7.7.4 Rope, Chain or Cable. All fuel systems repair areas/facilities shall be marked off 50 feet from all points on the aircraft with rope, chain, or cable. The roping of facilities applies to those areas of the structure that are normally open and is intended to control foot traffic into the facility. During combination air or exhaust purge an additional 50 feet radius downwind from the end of exhaust duct shall also be marked off.

2.7.8 Munitions, Explosive, and Pyrotechnic Devices. These devices by their nature are an additional source of fuel for a fire and may complicate rescue and fire fighting operations. The aircraft will be non-explosives loaded in accordance with T.O. 11A-1-33. Generally this means egress, survival kits, destructors, fire extinguisher cartridges, and engine starter cartridges may remain on the aircraft. These devices will be made safe in accordance with system manuals and T.O. 11A-1-33 as applicable. All munitions including 30mm and smaller including TP ammo will be downloaded when any of the following conditions are present:

a. The aircraft is in a hanger for fuel system maintenance.

b. An entry permit is required to perform the maintenance task.

c. Hot work is to be accomplished.

d. The location of the outside repair area limits are hinders Fire Department response.

Munitions do not have to be downloaded if the maintenance task requires removal/replacement, inspection, and test of externally mounted fuel system components.

2.7.9 Aircraft Operations.

2.7.9.1 Aircraft shall not be allowed to operate under their own power within 100 feet of fuel systems repair areas or exposed portions of aircraft in facilities. Refer to paragraph 2.7.6, for information concerning operation of aircraft radar and communications equipment in the vicinity of fuel systems repair areas and facilities.

2.7.9.2 Minor encroachment of the 100 foot limit is permissible when the aircraft is fully enclosed in a hangar. However, engine operation in adjacent hangars or from aircraft on nearby taxiways may create noise or other hazards. These operations shall be curtailed when they impact the ability to safely conduct fuel system maintenance. Generally this will require coordination between the MXG, LG and OG staff.

2.7.10 Externally Mounted Fuel System Components. Fuel system repairs which do not require fuel tank entry, depuddling, or purging operations may be accomplished in any facility, parking ramp, or open area approved for other types of aircraft maintenance. Aircraft power shall not be applied and nonessential equipment will be removed from the immediate area. Circuit breakers, power receptacles, and SPR connections shall be tagged to indicate maintenance is being performed. Electrical equipment will be approved for use in Class I hazardous areas. No other maintenance will be conducted on the aircraft during these repairs. Openings from the removed components shall be covered with locally manufactured caps or plugs to prevent fuel vapors from escaping through the opening. Barrier material, aluminum foil, plastic bags, etc., will not be used to cover the openings. The Fuels Section Chief will release the aircraft for other maintenance once the repairs are complete or caps/plugs are in place.

2.8 CONFINED SPACE ENTRY (FUEL CELL/TANK ENTRY).

2.8.1 General.

2.8.1.1 Confined space entry can be for various reasons (e.g., inspection, repair, rescue). Entry into IDLH atmospheres will not be conducted routinely. IDLH entries will be conducted for emergencies in accordance with AFOSH 91-25. Certain sequences of events may require entry into a confined space with hazards present beyond the scope covered in this manual, these entries will be coordinated with the local Safety, Fire Dept, BEF, and MXG/CC, LG/CC or civilian equivalent. Instructions contained within this chapter and other chapters of this T.O. will develop the requirements for “Permit Required Confined Spaces” in accordance with Air Force and OSHA health and safety directives. These procedures are for routine recurring entry in a non-IDLH atmosphere. Entry for rescue shall be conducted in accordance with the procedures set forth in the local rescue plan.

2.8.1.2 The requirements for the aircraft integral tanks and fuel cell confined space permit system are derived from Air Force and OSHA safety and health requirements.

2.8.2 Responsibilities.

2.8.2.1 The MXG/CC, LG/CC or equivalent is responsible for the safe execution of all entries into and work performed in aircraft fuel tanks and cells, and for issuing over his/her signature on the letter designating the Entry Authority and authorizing the issue of Entry Permits (Master Entry Permit).

2.8.2.2 Attendants have overall responsibility for monitoring the entry area inside and outside the aircraft fuel cell/

tank, including termination of the entry if unsafe conditions develop.

2.8.2.3 Entrants are responsible for complying with the conditions of the field permit, this T.O. and the directions of the attendant at all times, including vacating the tank/cell when so directed.

2.8.2.4 MXG or LG/CC, BEF, Safety, and Fire Prevention officials are responsible for evaluating and coordinating on the Master Entry Permit, in addition to those duties outlined by other Air Force directives.

2.8.2.5 Training will be provided by qualified individuals on the installation using lesson plans or training outlines approved by the Entry Authority, the responsible Safety office, BEF, and the Fire Department.

2.8.2.6 Vigilance is required on the part of all personnel who work in fuel cells/tanks (confined spaces).

2.8.2.7 Personnel Requirements. When entering a cell/tank a minimum of three people will be used. One 2A6X4 person (or civilian equivalent) shall enter the tank, one 2A6X4 person (or civilian equivalent) shall remain outside the tank as an attendant.

a. The Entry Authority shall designate a fuel tank entry chief for each tank entry. The fuel tank entry chief will have supervisory control over all other team members. Qualified attendants may serve as the tank entry chief.

b. The MXG/CC, LG/CC, or civilian counterpart may substitute a non-2A6X4 person as an attendant when circumstances require, such as work stoppage due to fuel system personnel manning shortages or surges in workload to sustain readiness. The acceptance of reasonable risk should be weighed by the person exercising this authority to assure that safety is not compromised. Any non-2A6X4 individual selected as an attendant shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief. The local training shall cover tank familiarization, safety equipment, grounding, bonding, purging procedures, depuddling, operations, using respirators, recognizing symptoms of toxicity from fuel and solvent vapors, and rescue/emergency procedures as well as the general duties of an attendant.

c. Training or recertifcation shall be conducted annually.

d. When authorized by the Entry Authority or Designated alternate an attendant may monitor more than one tank entry, as long as he can effectively perform the duties of an attendant.

e. When authorized by the Entry Authority or Designated alternate, the third person may perform the runner/equipment monitor duties for more than one cell/tank entry as long as the runner/equipment monitor remains in the immediate area of the cell/tanks, e.g., within shouting distance, and is otherwise capable of executing any responsibilities assigned as the runner/equipment monitor by the Emergency Response Plan.

2.8.3 Emergency Response Plan and Procedures.

2.8.3.1 Each repair activity in coordination with installation medical services, Fire Department, Safety, and BEF officials, will develop a written Emergency Response Plan. The plan will establish a rescue team consisting of personnel to remove individuals incapable of self-rescue from tanks from which such a removal is possible, and base or local emergency response agencies to provide immediate medical care, and removal if not otherwise possible. The plan will account for all foreseeable rescue situations. Minimum requirements are listed below:

WARNING

All attendants will have the capability of summoning the emergency response team on site. Unit rescue is first team rescue for all personnel entrapment. The equipment monitor cannot assume the attendant post unless he/she is fully qualified and have a person present to replace him/her as equipment monitor.

2.8.3.2 For those tanks/cells that entry for removal is possible, the plan will identify either the authorized attendant or the runner/equipment monitor for initial removal attempts employing the following procedures.

a. Prior to any tank entry for removal of an incapacitated entrant, the attendant will alert the emergency response team.

b. Make sure that the tank is being properly ventilated.

c. Determine, through contact with the entrant if possible, the nature of the emergency.

d. Assess the conditions of the tank.

e. Make any rescue attempts possible from outside the tank.

2.8.3.3 Emergency Response Plans will list equipment and facility requirements necessary to safely remove an incapacitated entrant.

2.8.3.4 Emergency Response Plans will define the roles and activities of all responding emergency agencies, including rescue from a tank from which removal by the attendant has failed or is not possible.

2.8.3.5 Rescue capability must exist for all shifts during which tank entry is accomplished.

2.8.3.6 Although the most likely rescue will be from a non-IDLH environment, the plan will account for rescue from an IDLH environment.

2.8.3.7 The plan will be exercised with all relevant base agencies at least annually, during which the rescue team will practice making removals from actual or simulated tanks. Dummies or mannequins can be used for the exercise.

2.8.4 Confined Space Entry Requirements.

2.8.4.1 General.

a. All aircraft integral tanks and fuel cells will be considered permit required confined spaces. A permit shall be obtained prior to making a tank entry.

b. If the maintenance or inspection procedures require only hand/arm entry into a confined space and there is no possibility of injury from electrical or mechanical hazards, no permit is required.

(1) Tanks containing atmospheres considered to be immediately dangerous to life and health (IDLH) will not be entered using the confined space entry procedures of this chapter. For the purposes of this T.O., IDLH is considered to be LEL of greater than 20% or (1200 ppm), oxygen content of 16% or less or greater than 23.5%, or a toxicity level of any chemical agents used in the tank at or above IDLH levels specified by BEF.

(2) Tank entries for the purposes of rescue will be performed by trained, predesignated teams as specified.

(3) All participants in tank entries at depot level will be trained as outlined in this chapter of the T.O. Unattended entry shall never be authorized.

2.8.4.2 Master Entry Permit. The Master Entry Permit certifies the Fuel Systems Repair Supervisor to act as the Entry Authority for aircraft fuel cell/tank entries. The Master Entry Permit does not authorize entrance into any permit- required space. The authorization letter will be developed by the organization performing fuel tank/cell entries and approved by MXG/CC, or LG/CC, Installation BEF, Safety, and Fire Prevention Officials. The AF Form 1024, Confined Space Entry Permit, which is approved for local reproduction (LRA), with addendums and modified as necessary to meet the requirements of this T.O. or a locally developed letter may be used. Table 2-3 is a sample Master Entry Permit.

a. The Master Entry Permit will be issued for a maximum of one year.

b. The Master Entry Permit will certify, by name and position, the Entry Authority and Designated Alternates.

c. The Master Entry Permit will describe the conditions under which the Entry Authority or Designated Alternates may issue Entry Permits including:

(1) Type aircraft to which the Master Entry Permit and Entry Permits will apply.

(2) General descriptions of the routine and recurring type work to be performed during permitted entries and the work centers which will be performing the work.

(3) Authorized atmospheric conditions of the tank (e.g., tank properly purged, LEL, Oxygen, toxicity at prescribed levels).

(4) Type chemicals, sealants, adhesives, etc. authorized to be used in the tank. Generally, any required by T.O. 1-1-3 procedures should be authorized, along with any other routinely used material that has been fully evaluated and approved by the local safety, fire, and BEF.

(5) Procedures, practices and personnel requirements for periods of deployment to non-Air Force installations or during readiness exercises and operations at remote locations.

(6) Additional location specific conditions deemed necessary by local BEF, Safety, or Fire Officials.

d. The Master Entry Permit will specifically state that any entry not consistent with the conditions of the Master Entry Permit will not be authorized by the Entry Authority or any Designated Alternates.

e. As part of the annual authorization process, the MXG/CC, LG/CC, BEF, Ground Safety, and Fire Prevention officials must review, validate and approve the Master Entry Permit. This approval will be based on reviews and assessments of:

(1) Maintenance fuel cell/tank familiarization training and related confined space training programs developed as required by MXG/CC, LG/CC, BEF, Ground Safety and Fire Prevention Officials.

(2) The selection process for Designated Alternate Entry Authorities.

(3) Entry Permit issuing procedures.

(4) The operation and condition of sampling equipment (i.e., combustible gas indicators and oxygen meters, and other direct reading instruments.).

(5) The condition and use of personal protective equipment.

(6) The organizations Fuel Cell/Tank Emergency Response Plan.

2.8.4.3 Designated Alternate Entry Authorities. Designated Alternates are selected by the Entry Authority and Certified on the Master Entry Permit. There should be sufficient Designated Alternates to make sure coverage of all operations and shifts. Designated Alternates will as a minimum be:

a. Fully qualified on aircraft fuel system maintenance.

b. Knowledgeable of the hazards of a confined space, the testing and monitoring requirements of the specific confined spaces, the rescue procedures, and the confined space entry requirements contained in this T.O.

2.8.4.4 Entry Permit Issue. The Entry Authority/Designated Alternate will:

a. Only issue an entry permit after all controls and testing are accomplished.

b. Never permit entry into a tank or cell with an IDLH atmosphere.

c. Make sure all entries and work performed adhere to the safety practices and procedures contained in this T.O.

d. Establish and maintain a system for controlling entry into all aircraft fuel tanks and cells.

(1) The Entry Authority or Designated Alternate will only issue a Entry Permit for tank entries performed under conditions consistent with the Master Entry Permit. Entry Permits may be issued for similar tasks performed under similar conditions in different tanks/cell on the same aircraft. The Entry Permit will cover the duration of the task(s) to be performed unless conditions under which the Entry Permit was issued change prior to task completion. The Entry Permit will never be issued for more than one year.

(2) The Entry Authority or Designated Alternates will amend or reissue the Entry Permit if conditions of the original Entry Permit change prior to task completion and if the changed conditions are consistent with the Master Entry Permit. Entry Permit conditions are considered changed if:

(a) The originally permitted task(s) change.

(b) The aircraft is moved.

(c) Conditions not in adherence to this T.O develop.

(d) Chemicals other than originally permitted are introduced into the tank.

(e) Previously non-permitted personnel require entry into the tank.

(f) Any condition outside the scope of the Master Entry Permit develop. Any conditions or changes not consistent with the Master Entry Permit require approval from MXG/CC, LG/CC, BEF, Ground Safety, and the Fire Department before entry.

(3) The Entry Permit will be a written document. The AF Form 1024, Confined Spaces Entry Permit, which is authorized for local reproduction (LRA), with addendums and modified as necessary to contain the requirements of this T.O. as well as additional guidance that may be dictated by local conditions or a locally developed form may be used. Table 2-2 is a sample Entry Permit.

(4) The Entry Permit will be available at the job site during tank entry. When the task is completed, the Entry Permit will be returned to the Entry Authority and canceled. The canceled permit shall be forwarded to the local Ground Safety Office and retained for one year.

e. Make sure all entrants are qualified for tank entry.

(1) Entrants, as a minimum, must be medically qualified, respirator certified in accordance with AFOSH 48-137, have received hazard communication training in accordance with AFOSH Standard 161-21, and had fuel tank/cell familiarization training as required by this chapter of this T.O. including: Confined space hazards related to fuel cells, personnel protective equipment requirements, and self rescue.

(2) Prospective entrants not meeting the above qualifications will not be permitted entry into a tank or fuel cell.

f. Make sure attendants are trained and available for all entries.

(1) The Entry Authority or Designated Alternate shall provide a fully qualified Fuel Systems Repair specialist to act as an attendant for all entries. Attendants will be knowledgeable of the following: the emergency response plan and procedures, proper use of communication equipment, procedures for summoning rescue team and positioning of emergency equipment, recognition of early behavioral signs of potential overexposure caused by chemicals used in the tank, and the duties of an attendant. Under certain exceptional circumstances, other than fuel cell repair specialists may be selected as attendants.

WARNING

Improperly executed fuel tank/cell rescue attempts will result in severe injuries or deaths. Attendants must never enter a permitted confined space, including for rescue, unless allowed by the Emergency Response Plan. In the event of an emergency, the attendant must summon help, and make all attempts possible to rescue the entrant without entering the tank or cell.

(2) The attendant will be stationed at the entrance and remain outside of the entered tank. Duties of the attendant include: monitoring of activities inside and outside of the tank for the detection of hazards; monitoring of individuals in the tank for signs of overexposure; limiting entry into the tank to Entry Permit authorized personnel only and preventing unauthorized personnel from entering the tank; evacuating all entered tanks in the event of an emergency or other hazardous situations within or outside of the tank(s) which would endanger the entrant(s); evacuating the tank for any condition which would cause the attendant to focus attention away from the tank; and implementing the Emergency Responses plan if needed.

(3) Attendants may monitor more than one tank entry if capable of performing the duties listed in this chapter of the T.O.

(4) The use of electronic or video personnel monitors are encouraged and may reduce the number of attendants required to monitor tank entries.

(5) These devices when used properly, provide nearly continuous monitoring of personnel inside large airframe tanks. If used, sufficient attendants to control the area around the space and prevent unauthorized entry will still be required. Such devices must meet NFPA 70 requirements for use in Class I environments.

2.8.4.5 DEPLOYED AIRCRAFT.

a. When deployed to another Air Force installation, all tank/cell entries will comply, to the maximum extent possible, with the requirements of the Master Entry Permit at the deployed location.

b. When deployed to Non-AF military installations, adhere to the requirements of Master Entry Permit at the home base to the greatest extent possible.

c. When deployed to a BARE base or remote location the unit will make provisions for at least two qualified fuel system repair specialists for each entry. The runner/equipment monitor will be selected from available on-site personnel and will be briefed on his/her duties including emergency response procedures. Adhere to the requirements of Master Entry Permit at the home base to the greatest extent possible.

d. Tank/cell entry will not be made until emergency medical response procedures appropriate to the location have been identified. The team will deploy with one combustible gas indicator, one oxygen indicator and sufficient airline respirators to make sure safe entry.

2.8.4.6 TRANSIENT AIRCRAFT.

a. When an aircraft is at an AF installation the fuel system repair specialist will coordinate all entries with local personnel. This individual will serve as the entry chief. Adhere to the requirements of Master Entry Permit at the host base to the greatest extent possible.

(1) If an additional entrants are required, the entry chief shall provide familiarization training to fuel systems repair specialist from the host base.

(2) The attendant and other personnel may be selected from the local fuel system repair shop. The attendant shall be briefed, by the entry chief, on the work to be performed and provided an overview of the aircraft fuel system/tank.

b. When an aircraft is at a non-AF installation, BARE Base, or remote location the unit will make provisions for at least two qualified fuel system repair specialists for each entry. The runner/equipment monitor will be selected from available on-site personnel and will be briefed on his/her duties including emergency response procedures. Adhere to the requirements of Master Entry Permit at the home base to the greatest extent possible.

c. Tank/cell entry will not be made until emergency medical response procedures appropriate to the location have been identified. The team will deploy with one combustible gas indicator, one oxygen indicator and sufficient airline respirators to make sure safe entry.

Table 2-2. Sample Entry Permit Authorization Letter

SAMPLE CONFINED SPACE ENTRY PERMIT (Entry Permit)

AIRCRAFT TAIL NUMBER:	AIRCRAFT LOCATION (Spot, Ramp)
JOB/TASK:	DATE DURATION: UNTIL TASK IS COMPLETE

COMMUNICATION PROCEDURES: RADIO_______TELEPHONE_______ ALARM______ RUNNER

MONITORING EQUIPMENT_______ DATE OF CALIBRATION_______
HAZARDS PRESENT: FUEL TYPE______ INERTING GAS______
CHEMICALS KNOWN TO BE PRESENT_________
CHEMICALS TO BE USED: THOSE AUTHORIZED IN T.O. 1-1-3 AND OTHER APPLICABLE TECHNICAL DIRECTIVES

PURGE METHOD: AIR______FLUID (FLUID USED)_______

OXYGEN LEVEL (MUST BE BETWEEN 19.5% AND 23.5%) ___DATE ___TIME _______
%LEL _________DATE _________TIME _______
TOXICITY (Date of last Bioenvironmental Engineering assessments) DATE_________

MONITORING REQUIREMENTS:
OXYGEN LEVEL:
AIR PURGE PRIOR TO FIRST ENTRY OF EVERY SHIFT AND EVERY FOUR HOURS THEREAFTER OR MORE OFTEN AS DEEMED NECESSARY

FLUID PURGE: PRIOR TO FIRST ENTRY OF EVERY SHIFT OR MORE OFTEN AS DEEMED NECESSARY

AIR PURGE: PRIOR TO FIRST ENTRY OF EVERY SHIFT AND EVERY FOUR HOURS THEREAFTER OR MORE OFTEN AS DEEMED NECESSARY

LOCATION OF HAZARD SIGNS: SIGNS PLACED IN ACCORDANCE WITH T.O. 1-1-3.
PRE-ENTRY CHECKLIST COMPLETED AND AVAILABLE?_______

Table 2-2. Sample Entry Permit Authorization Letter - Continued

ISOLATION PROCEDURES:
LOCKOUT/TAGOUT (ELECTRICAL) NOT REQUIRED_______COMPLETED _________
LOCKOUT/TAGOUT (MECHANICAL) NOT REQUIRED_______COMPLETED _______

VENTILATION: CONTINUOUS MECHANICAL VENTILATION REQUIRED DURING ALL ENTRIES
EQUIPMENT USED_______

PERSONAL PROTECTIVE EQUIPMENT:
RESPIRATOR_______COVERALLS _______OTHER _______

REMARKS/ADDITIONAL INFORMATION:
ALL TYPED INFORMATION IS EXTRACTED FROM T.O. 1-1-3.

RESCUE TEAM: (MINIMUM OF TWO PEOPLE) IN CASE OF EMERGENCY CONTACT _________
(THE PERMIT SHOULD DESIGNATE WHO (EITHER THE ATTENDANT OR RUNNER) IS ASSIGNED RESPONSIBILITY TO PARTICIPATE ON THE EXTRACTION TEAM (IN ACCORDANCE WITH THE EMERGENCY RESPONSE PLAN.))

LOCATION OF RESCUE EQUIPMENT: SPARE RESPIRATOR IS ON SITE
OTHER EQUIPMENT_________

NAME OF ATTENDANT_________
(ATTACH LIST IF NECESSARY)

AUTHORIZED ENTRANTS_______
(ATTACH LIST IF NECESSARY)

ENTRY CHIEF _______

ENTRY AUTHORITY_______SIGNATURE/DATE _______
TITLE_______

Table 2-3. Sample Entry Permit Authorization Letter

Sample Master Entry Permit

ORGANIZATION________ISSUE DATE ________EXPIRATION DATE________

CHAPTER 1. ENTRY AUTHORITY AND DESIGNATED ALTERNATES: The below listed individuals are authorized to issue Field Permits for entry into (list specific types of aircraft) fuel tanks/cells to perform tasks listed in CHAPTERs 2 and 3 below.

NAME	JOB TITLE	UNIT	JOB TITLE
Entry Authority		Designated Alternate	Designated Alternate

CHAPTER 2. FUEL SYSTEM REPAIR TASKS AND EJECTED TANK CONDITIONS. The tasks listed below will be performed by personnel from the Fuels System Repair Work Center. Personnel on entry teams are trained as required by TO 1-1-3 and all entries will be made in accordance with the requirements of TO 1-1-3.

a. General Tank Conditions: Tanks will be continuously air purged when entered. LEL will be maintained at 10% or less (20% for foam removal) and oxygen content will be between 19.5 and 23.5%.

b. Specific Tasks.

TASK NAME TYPE	GOVERING T. O. OR DIRECTIVE	CHEMICALS OR HAZARDOUS MATERIALS	EXPECTED AIRBORNE LEVELS/DATE OF BEF	PERSONAL PROTECTIVE EQUIPMENT/ACFT RESPIRATOR EVALUATION

(Use this chapter to list the recurring inspection and maintenance tasks performed by Fuel Systems Repair personnel. Task names should be as brief, but as descriptive as possible. Listing the date of the last BES Evaluation is highly recommend because that information will be required on the Field Permit.)

3. NON-FUEL TANK/CELL REPAIR TASKS AND EXPECTED CONDITIONS. Tank entry for the purposes of completing the below listed tasks will be performed by the Work Centers listed. Entry teams are trained as required by TO 1-1-3 and all entries will be made in accordance with the requirements of TO 1-1-3.

a. General Tank Conditions: Tanks will be continuously air purged when entered. LEL will be maintained at 10% or less (20% for foam removal) and oxygen content will be between 19.5 and 23.5%.

b. Specific Tank Conditions: (Insert a table, or listing similar to the one above in CHAPTER 2. Include the Work Centers performing the work.)

CHAPTER 4. ATMOSPHERIC MONITORING EQUIPMENT. (Use this chapter to list the specific pieces of equipment used to monitor atmospheric conditions combustible gas meter, Oxygen analyzer, etc, in a fuel tank/cell. List by name and model number. Calibration requirements should also be listed.)

Table 2-3. Sample Entry Permit Authorization Letter - Continued

CHAPTER 5. DEPLOYMENT AND READINESS PROCEDURES. (The suggested language provided below will require extensive tailoring to meet the expected mission requirements of a specific organization. The intent of this chapter is to make sure that tank/cell entries made at other than the home base are done consistent with Air Force safety and health requirements. Tasks to be performed at deployed locations should be defined and pre-planned to the extent possible. The permit would then list such items as required personal protective equipment to be deployed, minimum manning, and emergency response procedures.)

When deployed to another Air Force installation, all tank/cell entries will comply with the requirements of the Entry Permit Authorization Letter at the deployed location. When deployed to Non-AF military installations, adhere to the requirements of this permit to the extent possible. When deployed to a bare base or remote location the unit will make provisions for at least two qualified fuel system repair specialists for each entry. The runner/equipment monitor will be selected from available on-site personnel and will be briefed on his/her duties including emergency response procedures. Tank/cell entry will not be made until emergency medical response procedures appropriate to the location have been identified. The team will deploy with one combustible gas indicator, one oxygen indicator and sufficient air-line respirators to make sure safe entry.

CHAPTER 6. EMERGENCY RESPONSE PLAN.

Where Maintained____________________

Last Review/Update__________

CHAPTER 7. ADDITIONAL REQUIREMENTS (Use this chapter to list any additional requirements mandated by local conditions, if any).

CHAPTER 8. AMENDMENT PROCEDURES. Field Permits for tank/cell entries not consistent with this Master Permit will not be issued without prior approval from MXG/CC, LG/CC, Safety, BEF, and the Fire Department. After receiving approval, routine and recurring tasks may added to this Permit on attached sheets with reference to the appropriate Permit chapter.

CHAPTER 9. APPROVALS

Entry Authority (signature/date) Safety Office (signature/date)

BEF (signature/date)

Fire Department (signature/date)

DCM, MXG/CC, LG/CC, or civilian equivalent (signature/date)

NOTE: This Table is to provide a suggestion on the form and style of the Master Permit. The AF Form 1024, Confined Spaces Entry Permit, as well as local produced forms or letters, may be used. As a minimum, Entry Permit Authorization Letter must contain the elements listed in paragraph 2.8.4.2.

2.9 AIRCRAFT AND FACILITIES PROTECTION.

2.9.1 Fuel System Repair Operations.

2.9.1.1 JP-5 and JP-8 Serviced Aircraft. Fueling, defueling, draining, depuddling, fuel transfer, or purging operations, of fueled aircraft, may be accomplished in an approved fuel systems maintenance facility or an approved open area.

2.9.1.2 JP-4 Serviced Aircraft. Fueling and defueling shall not be accomplished inside any facility. Draining, depuddling, fuel transfer, or purging operations, of fueled aircraft, may be accomplished in an approved fuel systems maintenance facility or an approved open area.

2.9.1.3 No other maintenance will be permitted during air or fluid purging, depuddling or defueling operations.

2.9.2 Fire Protection.

2.9.2.1 Fuel Systems Repair Facilities. Facilities shall have fire protection systems which meet the requirements of Engineering Technical Letter (ETL) 90-09 or other superseding ETL.

2.9.2.2 Fire-Safe Determination - Oxygen Content and Combustible Vapor Lower Explosive Limit (LEL) Test Procedures. Oxygen content of the tank shall be checked prior to checking the LEL. Equipment shall be calibrated and operated in accordance with the manufacturer's instructions or AF technical orders. The tank atmosphere shall be checked prior to the first entry of every shift and; every four hours for air purged aircraft (every eight hours for fluid purged aircraft) or as often as deemed necessary to determine if the aircraft is entry/fire-safe. Readings should be taken at various points in the tank to ensure the atmosphere is acceptable.

2.9.2.3 Fuel Systems Repair Areas. Fuel systems repair areas shall be equipped with at least two 150 pound Halon 1211 fire extinguishers. Additional extinguishers shall be provided when required by the Base Fire Marshal. Each extinguisher shall be inspected for serviceability. Fire extinguishers should be positioned such that they do not create a hazard in the area but are available for immediate use.

2.9.2.4 Fuel vapors shall be extracted from the facility. Exhaust shall be operated during defuel, fuel, air purge, fuel transfer, and draining operations unless ducts are used to direct the vapors outside.

2.9.2.5 Hot Work. The Fire Department shall approve all hot work (e.g. grinding, welding, and brazing) on aircraft and fuel system repair facilities. (refer to instructions on AF Form 592)

2.9.3 Aircraft Mooring and Ground Handling.

Aircraft mooring and groundhandling shall be in accordance with the applicable weapon systems technical order.

2.9.4 Aircraft Electrical Systems.

2.9.4.1 Batteries. All batteries shall be disconnected, in accordance with the weapon system manual, and cables (or batteries) tagged with either an AF Form 1492 or 979. External power receptacles shall be tagged with an AF Form 1492 or 979.

2.9.4.2 Fuel quantity Wiring Harness Repairs. When harness repairs are required, all repairs will be made in accordance with TO 1-1-14 and performed outside the tank or cell. Ensure open tanks/cells are purged to at least a 1.5 percent LEL or less. All open tanks/cells will have LEL monitored continuously.

2.9.4.3 Fuel Probe Testing. The test may be accomplished while the probe is electrically connected to the aircraft using a GTF-6, GTF-20, or equal provided there is no fuel or fuel vapor in the vicinity of the equipment and the tank is drained and purged to less than 1.5% LEL.

2.9.4.4 Electrical Conduit Repairs. Fuel leaks in electrical conduit which enters/exits fuel tanks shall not be repaired by applying sealants externally or by using other temporary repairs to the conduit. When fuel is discovered in an electrical conduit the affected component shall be repaired or replaced.

2.9.5 Grounding/Bonding.

2.9.5.1 Grounding/Bonding Hardware. Grounding/bonding wires shall be constructed to fasten directly to the aircraft's static grounding system. All grounding/bonding hardware shall be inspected using the criteria outlined in TO 00-25-172.

2.9.5.2 Aircraft.

a. Temporary Repairs (Chapter 4). The aircraft need not be grounded. Personnel shall touch an aircraft ground receptacle (to neutralize static charge and prevent static discharge from occurring near fuel vapors) prior to performing inspections and repairs.

b. Other Maintenance and Inspections. The aircraft shall be grounded when in fuel system repair areas/ facilities and remain grounded for the duration of the maintenance or inspection. (Ref. 00-25-172)

2.9.5.3 Support Equipment. Powered and non-powered support equipment shall be bonded to the aircraft by attaching a cable from the equipment to aircraft receptacle.

2.9.5.4 Workstands. All metallic workstands shall be equipped with a static discharge plate made of copper, zinc or zinc coated material. The plate shall be mounted or attached to the handrail at the entrance to the stand, unless a static discharge plate already exists (as per the stand's technical order). The plate shall be marked "PERSONNEL STATIC DISCHARGE PLATE."

2.9.5.5 Drop, External, Ferry, Benson, Weapons Bay Tanks. Ground metallic tanks during periods of in-tank inspection and maintenance. During inspections and maintenance bond blower ducts, maintenance stands, and support equipment to metallic tanks. The tanks do not need to be grounded when stored, parked, or during other periods when in-tank work is not being accomplished. Prior to draining or pouring fuel from a metallic container/tank into a metallic container/tank, momentarily touch the container to the tank to neutralize the charge. (Ref. 00-25-172)

2.9.5.6 Non-metallic Tanks, Workstands, and Other Objects. Non-metallic objects (e.g., non-metallic tanks, fiberglass ladders, and rubber buckets) do not need to be grounded or bonded.

2.9.6 Housekeeping. Fuel systems repair areas/facilities shall bemaintained to a reasonable level cleanliness and order. Oil, grease and fuel contaminated rags shall be placed in proper containers. Spills and leaks shall be cleaned/contained to prevent creating a fire or trip hazard. Small spills (Class I, not over two feet in any direction) shall be immediately cleaned. If a large amount of fuel is spilled (Class II or III) during draining or transfer, the operation shall be stopped, power turned off, and the fire department notified. Work shall not resume until the area is determined safe by the fire department. Equipment shall be stowed or positioned so as not to block passage, or create a hazard. During fuel system maintenance, the facility shall not be used to store materials, equipment, vehicles, etc., which could create a fire hazard, obstruct aircraft egress, or hinder fire fighting and rescue operations.

2.9.7 Fuel Foam Storage.

2.9.7.1 Indoor Storage. Foam stored indoors shall be placed in clean electro-static free plastic bags or canvas bags or placed on a clean electro-static free plastic or canvas ground cloth and covered with clean electro-static free plastic or canvas if the foam is to be reused. The bags shall be either placed in a segregated storage area or retained near the aircraft. Segregated storage areas shall be approved by the base fire marshal and ground safety office. Foam shall not be stored in direct sunlight, exposed to high temperatures or high humidity.

2.9.7.2 Outdoor Storage. Short term outdoor storage of foam is authorized for aircraft which are in fuel systems repair areas not co-located with an approved fuel system repair facility or segregated foam storage area. Foam shall be protected from exposure to particulate contamination, direct sunlight and water. Foam should either be placed in clean electro-static free plastic, or canvas bags, or placed on a clean electro-static free plastic or canvas ground cloth and covered with clean electro-static free plastic or canvas. Foam should be stored in shaded areas around or under the aircraft.

2.9.7.3 Foam which is not to be reused shall be stored and disposed of in accordance with applicable environmental regulations.

2.9.8 Severe Weather.

2.9.8.1 Field Level Maintenance. When high winds are considered dangerous (usually 30 kts/hr or higher) or thunderstorms/lightning are within a three nautical mile radius of the repair site operations shall be suspended. The Logistics Group Commander in coordination with the Base Weather Officer will develop and set up warning procedures so timely precautionary measures may be taken when conditions warrant. When the Base Weather Officer provides notification of severe weather (usually at five (5) miles), the Fuels Section Chief shall take action as necessary to ensure operations are suspended by the time the severe weather is within three (3) nautical miles. When operations are suspended, access panels, filler caps and other openings removed for maintenance shall be temporarily closed. If temporary panels are used, panels will be manufactured from non-conductive material.

2.10 MAJOR DISASSEMBLY (CONTRACTOR AND FIELD).

Aircraft at activities for major disassembly shall have all fuel removed from the fuel system (pumps, tanks, lines, and other components) prior to moving the aircraft into a non-approved facility. The aircraft shall be checked to ensure a fire-safe condition is maintained.

2.11 CHECKLIST.

2.11.1 General Checklist for Tank Entries. Entry Permits are issued for a specific time frame. The following checklist is provided for use at the beginning of each shift (or more often as deemed necessary) over which a permitted entry task or other non-tank entry repair is performed. All fuel tank entries must be included on AF Form 1024 or local permit.

a. Check that an Entry Permit is issued and complied with (Oxygen checked, LEL checked, rescue notified, etc).

b. Check aircraft safe for maintenance.

c. Check personal protective equipment available and serviceable.

d. Check required personnel on-scene and in position.

e. Check required warning signs posted.

f. Make sure only authorized personnel are in area.

g. Turn on and check ventilation and climate control equipment, as necessary.

h. Check communication equipment.

i. Check fire alarm systems.

j. Turn on and check combustible gas and toxic alarm system if applicable. Calibrate as necessary.

k. Check all support equipment properly positioned, serviceable and bonded to the aircraft.

l. Check only authorized tools/equipment to be used in tank.

m. Notify fire department when fuel system repair is to begin.

n. Check that all hand tools required for fuel area maintenance are carried in a nonmetallic container.

o. Check that maintenance is not accomplished on the aircraft while inerting, depuddling and purging operations are being accomplished.

p. Check that a fire-safe condition (20% LEL or (1200 ppm) or less) is maintained (10% LEL or (600 ppm) or less (20% (1200 ppm) for foam removal) for tank entry). Stop purging or depuddling operations on aircraft when thunderstorm/ lightning is within a five-mile radius of the work area.

q. Check that required fire extinguishers are ready for use.

r. Check that the work area is clear of all nonapproved equipment.

s. Ensure that test/support equipment which is attached to the aircraft has “Remove Before Flight” and/or“ Remove Before Fueling/Defueling” streamers attached.

t. Make sure shift supervisors or designated representative is conducting a safety inspection of repair areas at the beginning of each shift.

2.11.2 General Checklist for Fuel Repair Area or Facility. Each fuel systems repair area shall have a checklist, work sheet or job guide available for use. The following check list is provided to cover general procedures that are required to position an aircraft in a fuel system areas and prepare the aircraft for maintenance or tank entry. This checklist is general in nature and is not intended to cover peculiarities of individual aircraft or facilities. Therefore, a specific aircraft or fuel system checklist should be used if available.

2.11.3 Check that egress system and oxygen system (OBOGS/MSOGS) or LOX converter is removed or made safe prior to opening any fuel tank/cell. Make sure all munitions are removed/downloaded.

NOTE

Aircraft serviced with Jet fuel, requiring tank/ cell entry shall be defueled as required before being placed in a fuel system repair area. Defueling may be accomplished in an open repair area.

a. Make sure shift supervisors or designated representative is conducting a safety inspection of repair areas at the beginning of each shift.

b. Review aircraft 781 forms and brief personnel.

c. Check that egress system and fire bottles are made safe and make sure all munitions are removed/ downloaded.

d. Check that all aircraft batteries are disconnected or made safe in accordance with the system peculiar technical order and tagged as required.

e. Check that the aircraft external power receptacles and fuel control panel are tagged with AF Form 979 or 1492.

f. Check that open areas are clear and properly identified.

g. Check that required fire extinguishers are ready for use.

h. Check that the work area is clear of all nonapproved equipment.

i. Check that the fire department has been notified.

j. Check that emergency communications is established.

k. Check that a fresh water supply is available for eye wash emergency.

l. Check floor drains to make sure they are open and turn on exhaust fans.

m. Check fuel spillage storage tank level.

n. Check to make sure water flush valves operate.

o. Make sure all support equipment used within the fuel cell repair area is bonded to the aircraft.

p. Make sure that toolboxes that are mounted on rubber wheels or mats only are brought into the fuel cell repair area.

q. Check personnel for proper clothing, equipment and removal of jewelry and spark/flame producing devices prior to entry into the fuel system repair area.

r. Make sure that personnel are checking/inspecting their shoes for exposed tacks or metal prior to entering a fuel system repair area.

s. Position the aircraft in an approved fuel systems repair area or facility.

t. Check that the aircraft is properly grounded in accordance with applicable aircraft technical manuals.

u. Check that the aircraft is parked, chocked and moored as per applicable aircraft technical manuals.

CHAPTER 3
AIRCRAFT FUEL SYSTEMS MAINTENANCE FACILITIES AND AREAS

3.1 General.

The use of segregated facilities and areas for fuel systems repair is essential for safe and efficient fuel systems maintenance operations. These facilities provide a safer place to perform fuel system repair and provide the needed climatic conditions to ensure quality fuel systems maintenance. The areas and facilities described in this chapter provide necessary protection for both the aircraft and personnel from a variety of hazards.

3.1.1 Permitted Operations. Fuel system maintenance facilities are intended to support the complete range of operations related to fuel system maintenance including those normally restricted from being conducted inside hangars or other structures. These normally restricted operations, which are permitted in fuel system maintenance facilities, include but are not limited to: Partial and complete defuel/refuel of aircraft; depuddling and purging of fuel tanks; cells and components; fuel transfers within the aircraft; and pressurization testing.

WARNING

- This chapter is not intended to be used as design criteria for facility construction. The requirements of this section are extracted from referenced documents or provided by safety and civil engineering functions. Use of this section as a design document could cause serious injury or mission impairment.
- Use of a facility that does not meet the requirements of the applicable design criteria could create a fire hazard risk. Permanent waivers to fire protection requirements shall be approved in accordance with ETL 02-1. Temporary waivers to fire protection requirements until corrections can be made may be approved by the MAJCOM fire protection engineer (or MAJCOM fire protection manager in the absence of a MAJCOM fire protection engineer) (refer to paragraph 3.1.2.1).

3.1.2 Approval. Facilities and areas shall be designated and approved for fuel system maintenance use based on the requirements of this technical order.

3.1.2.1 Facilities not meeting the requirements of this technical order may be approved based on an approved Wing/base corrective action plan coordinated through Wing/base Safety. MXG/CC, LG/CC, and Civil Engineering (Fire Protection) by restricting some of the normally permitted operations listed above and implementing other actions until corrections can be made. The approved base corrected action plan shall include the Risk Assessment Code (RAC)/project code, proposed completion date, and proposed operating procedures. In the absence of MAJCOM policy directing otherwise, the corrected action plan shall be forwarded to the following agencies in the MAJCOM: Fire Protection, Ground Safety, MXG, and LG.

3.1.2.2 Facilities may be temporarily approved for emergency or minor repairs in non-approved areas (except repairs that are performed in accordance with paragraph 2.7.10) by the MXG/CC, or LG/CC upon evaluation and concurrence by the Fuels Section Chief, Wing Safety, Fire Protection and Bioenvironmental. The use of temporary facilities should only be considered after priority of the mission and the availability of other facilities (primary fuel systems docks/repair facilities shall be utilized first). The use of a temporary facility shall be approved on a case-by-case basis. Temporary facility usage shall not be considered strictly for ease of maintenance (e.g., to prevent towing of aircraft), but should be considered only during peak workloads and to prevent mission degradation.

3.1.3 Exceptions. Fuel systems maintenance may be performed in any hangar on aircraft which have never been fueled or on aircraft which have been completely fluid purged and drained in accordance with this technical order.

3.1.4 New Facility Requirements. MIL-HDBK 1190, MIL-HDBK 1008 (current edition) and Engineering Technical Letter 02-1 Fire Protection Engineering Criteria - New Aircraft Hangars provide guidance for the construction of new fuel system maintenance facilities.

3.1.5 Existing/Modified Facilities Requirements. The requirements of this technical order shall be used to evaluate existing/modified fuel system maintenance facilities. For facilities not meeting these requirements refer to paragraph 3.1.2.1.

3.1.6 When facilities must be converted to permit fuel system maintenance activities or major improvements to an existing facility, improvements will be based on the requirements of paragraph 3.1.4.

3.1.7 Temporary Facilities. The requirements of this technical order shall be used to evaluate existing facilities for limited use as a fuel system maintenance facility.

3.1.8 Open (Outside) Fuel Systems Repair Areas. The requirements of this technical order shall be used to evaluate outside areas for fuel system maintenance.

3.2 Fuel System Repair Facilities Requirements.

3.2.1 New Facilities. All new fuel system maintenance facilities shall provide:

3.2.1.1 As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

3.2.1.2 An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For all aircraft provide a complete automatic overhead water only sprinkler system and a low-level high expansion foam system.

3.2.1.3 Showers:

3.2.1.3.1 Emergency eye wash fountains and emergency personnel showers with privacy enclosure to permit complete disrobing shall be provided in the aircraft servicing area. Emergency eye wash and showers shall provide water through a thermostatic mixing valve.

3.2.1.3.2 Changing areas, locker space, scrub sinks, and personnel showers shall be provided for both male and female personnel in all fuel system maintenance facilities. Scrub sinks shall be hands free type and shall permit the washing and rinsing of hands and arms to the shoulder. Scrub sinks and showers shall provide water through a thermostatic mixing valve. These areas shall be accessible from the aircraft servicing area without passing through break rooms or offices to prevent fuel contamination. Where two or more fuel system maintenance facilities are located adjacent one another changing areas, locker space and personnel showers for the total personnel assigned all facilities may be combined and located in one facility. Scrub sinks shall be provide in each facility. Scrub sinks in facilities without changing areas, locker space, and showers may be located in the aircraft servicing area.

3.2.1.4 At least two flight line type 150 lb. HALON 1211 wheeled fire extinguishers shall be located within a 50-ft (15.2-m) distance, one on each side of the aircraft undergoing maintenance.

3.2.1.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in a sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3.2.1.6 The Bioenvironmental Engineering Flight is responsible for evaluating industrial ventilation systems. A system is considered effective if all personal exposures are below respective occupational exposures limits (OELs). The BEF conducts personal air sampling to make this determination.

3.2.1.6.1 Area ventilation systems are provided in new fuel system maintenance facilities. Depending on the aircraft being serviced addition ventilation may be required for tank exhaust.

3.2.1.6.2 Drains and drainage trenches are not required in new fuel system maintenance facilities. If drainage is provided drainage trench ventilation is not required.

3.2.1.7 Climatic Control Units (CCU) are required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3.2.1.8 Sufficient grounding points provided throughout the facility.

3.2.1.9 Electrical systems shall be Class I Division 1, (Zone 1) below the floor level, Class I Division 1 (Zone 1) through out foam rooms, Class I Division 2, (Zone 2) through-out the hangar aircraft maintenance area up to 18 inches and Class I Division 2, (Zone 2) within 5 feet of the aircraft, and all wall mounted outlets and switches shall be Class I, Division 1 (Zone 1). To ensure no unclassified tools or equipment are taken into the classified area around the aircraft, wall mounted outlets and switches are required to be classified even though they are outside the classified area.

3.2.1.10 Office space, break room, support equipment/ tool room, and restrooms with climate control and positive pressure ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area. Rooms shall also be provided for tele-communications, utility/mechanical, and fire protection systems.

3.2.1.11 Shop space including foam/cell rooms to service/ repair fuels system components as required for the specific aircraft(s) maintenance.

3.2.2 Existing Facilities. Existing structures designed, constructed, and/or modified specifically for fuel systems maintenance (commonly referred to as definitive docks or modified docks) shall have the following:

NOTE

Existing general purpose and special purpose hangars meeting or exceeding this criteria may be converted to fuel system maintenance applications.

3.2.2.1 As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

3.2.2.2 An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. The following existing fire suppression systems are acceptable in the aircraft servicing area:

3.2.2.2.1 A complete automatic overhead water only sprinkler and a low-level high expansion foam system.

3.2.2.2.2 A complete automatic overhead water deluge.

3.2.2.2.3 A complete total flooding high expansion foam system.

3.2.2.2.4 A complete automatic overhead foam-water deluge (for fighter aircraft only).

3.2.2.2.5 A complete automatic overhead closed-head pre-action foam-water sprinkler systems (for fighter aircraft only).

3.2.2.2.6 A complete automatic overhead wet pipe foam-water sprinkler systems (for fighter aircraft only).

3.2.2.2.7 Systems 3-2.2.2.4, 3-2.2.2.5, & 3-2.2.2.6 when combined with a low-level fixed or automatic oscillating foam-water nozzle system or a low-level high expansion foam system are acceptable for large frame aircraft.

3.2.2.3 Emergency eye wash fountains and personnel showers shall be provided.

NOTE

Remotely located facilities with out a potable water supply shall be permitted to use portable eyewashes and showers.

3.2.2.3.1 Two ea. changing areas, locker space, scrub sinks, and personnel showers shall be provided for both male and female personnel in all fuel system maintenance facilities. Scrub sinks shall be hands free type and shall permit the washing and rinsing of hands and arms to the shoulder. Scrub sinks and showers shall provide water through a thermostatic mixing valve. These areas shall be accessible from the aircraft servicing area without passing through break rooms or offices to prevent fuel contamination. Where two or more fuel system maintenance facilities are located adjacent one another changing areas, locker space and personnel showers for the total personnel assigned all facilities may be combined and located in one facility. Scrub sinks shall be provide in each facility. Scrub sinks in facilities without changing areas, locker space, and showers may be located in the aircraft servicing area.

3.2.2.4 At least two flight line type 150 lb. HALON 1211 wheeled fire extinguishers shall be located within a 50-ft (15.2-m) distance, one on each side of the aircraft undergoing maintenance. Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

3.2.2.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in an sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3.2.2.6 Aircraft maintenance area, tank exhaust and ventilation systems required to meet current bioenvironmental instructions for personnel safety. The Bioenvironmental Engineering Flight is responsible for evaluating industrial ventilation systems. A system is considered effective if all personal exposures are below respective occupational exposures limits (OELs). The BEF conducts personal air sampling to make this determination. The following ventilation systems may be found:

3.2.2.6.1 Trench ventilation systems consist of trenches in the floor normally roughly parallel to the wing leading and/or trailing edges. Large axial exhaust fans ventilate these trenches. Such trenches must be connected to a fluid drain with an oil water separator. Where such systems are present they must be fully operational for fuel system maintenance operations to be conducted.

3.2.2.6.2 Area ventilation systems consist of large centrifugal exhaust fans at the exterior walls, which draw air across the hangar floor and exhaust it outside the hangar. Where such systems are present they must be fully operational for fuel system maintenance operations to be conducted.

3.2.2.6.3 Tank exhaust ventilation systems consist of permanently installed exhaust fans designed to be connected to tank exhaust ducts providing discharge directly outside.

3.2.2.6.4 Trench drain ventilation systems consist of small trenches in the floor normally across the doors or down the sides of the hangar with some type of exhaust fan to the outside. The trench drains themselves are required in fuel system maintenance hangars without a fire suppression system or with a water only deluge system. Such trenches must be connected to a fluid drain with an oil water separator. These exhaust fans are not required and may not substitute for the ventilation systems in paragraph 3-2.2.6.2. These trench drain ventilation systems may be removed even when the trench drain is required to remain.

3.2.2.7 Climatic Control Units (CCU) required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3.2.2.8 Sufficient grounding points provided throughout the facility.

3.2.2.9 Electrical systems shall meet one of the following criteria depending upon when facility was constructed:

3.2.2.9.1 Pre 1983, Class I Division 1, (Zone 1) through out foam cell rooms, Class I Division 1, (Zone 1) below the floor level and through out the hangar aircraft maintenance area to 4 foot above the floor and Class I Division 2, (Zone 2) up to 18 inches above the floor in all adjacent areas not suitable cut off from the hangar aircraft maintenance area.

3.2.2.9.2 1983 - 1996, Class I Division 1, (Zone 1) below the floor level, Class 1 Division 1, (Zone 1) through out foam/cell rooms, Class I Division 2 (Zone 2), through out the hangar aircraft maintenance area up to the height of the hangar door and Class I Division 2 (Zone 2), up to 18 inches above the floor in all adjacent areas not suitably cut off from the hangar aircraft maintenance area.

3.2.2.9.3 1996 - Present, Class I Division 1, (Zone 1) below the floor level, Class I Division 1 (Zone 1) through out foam/cell rooms, Class I Division 2, (Zone 2) throughout the hangar aircraft maintenance area up to 18 inches and Class I Division 2, (Zone 2) within 5 feet of the aircraft, and all wall mounted outlets and switches shall be Class I, Division 1 (Zone 1). Wall mounted outlets and switches are required to classified even though they area outside the classified area to ensure no unclassified tools or equipment are taken into the classified area around the aircraft.

3.2.2.10 Office space, break room, support equipment/ tool room, and restrooms with climate control and positive pressure ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area. Rooms shall also be provided for telecommunications, utility/mechanical, and fire protection systems.

3.2.2.11 Shop space including foam rooms to service/ repair fuels system components as required for the specific aircraft(s) maintenance.

3.2.3 Temporary Repair Facilities Requirements.

3.2.3.1 All aircraft fuel tanks (to be worked) shall be defueled and initially drained prior to entry into facility. Additional draining shall be accomplished using approved drain containers methods. Temporary facility doors shall remain open during tank purging and depuddling operations until an entry safe condition is reached and maintained.

3.2.3.2 Only equipment approved for fuel systems maintenance will be used in temporary facilities.

3.2.3.3 Personnel shall have access to:

3.2.3.3.1 Emergency eye wash fountains and personnel showers shall be provided.

NOTE

Remotely located facilities with out a potable water supply shall be permitted to use portable eyewashes and showers.

3.2.3.3.2 Access to changing areas, locker space, scrub sinks, and personnel showers shall be provided for both male and female personnel.

3.2.3.4 Purge exhaust ducts shall be positioned outside the facility doors, and positioned to prevent fuel fumes from traveling back into the facility. These ducts will be marked off an additional 50 foot radius from the end of the duct.

3.2.3.5 All safety requirements outlined in section III of this Technical Order shall be met prior to using a temporary facility.

3.2.3.6 At least two flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be located within a 50-ft (15.2-m) distance, one on each side of the aircraft undergoing maintenance. Additional extinguishers shall be provided as required by the base fire Marshall.

3.2.3.7 Any adjoining offices shall be isolated or evacuated during fuel systems maintenance to prevent unauthorized entry and endangerment of personnel not associated with the on-going fuel systems maintenance. Controlled entry into the area is paramount.

3.2.3.8 Fuel transfer, defuel or refuel operations shall not be accomplished in a temporary facility.

3.3 Open (Outside) Fuel System Repair Area Requirements.

3.3.1 An open fuel system repair area is any area that has been approved by the MXG/CC, or LG/CC with coordination from the Fuel Systems Element Chief, Wing Safety, Bioenvironmental, Fire Protection, and the Airfield Manager to perform aircraft fuel systems repairs in an open/ outside area.

3.3.1.1 The area shall be marked off in accordance with chapter 2 of this manual. An additional 50-feet may be required if exhaust purge is used (refer to paragraph 2.7.7.4) See Figure 3.1.

3.3.1.2 The fuel systems work accomplished in an outside area is highly dependent upon weather conditions and available authorized portable equipment. All portable electrical equipment and connections used in hazardous areas shall meet the requirements of the NEC for Class 1, hazardous locations.

3.3.1.3 Personnel will have access to:

3.3.1.3.1 Emergency eye wash fountains and personnel showers shall be provided.

NOTE

Remotely located facilities with out a potable water supply shall be permitted to use portable eyewashes and showers.

3.3.1.3.2 Access to changing areas, locker space, scrub sinks, and personnel showers shall be provided for both male and female personnel.

3.3.1.4 At least two flight line type 150 lb. HALON 1211 wheeled fire extinguishers shall be located within a 50-ft (15.2-m) distance, one on each side of the aircraft undergoing maintenance. Additional extinguishers shall be provided as required by the base fire Marshall.

3.3.1.5 Adjacent aircraft shall not be allowed to operate under their own power within 100 feet of the repair area (refer to paragraph 2.7.9). They shall also be limited from operations where jet blasts or noise factors could affect safety as outlined in chapter 2 of this T.O. and the applicable aircraft systems technical orders.

3.4 Operations.

3.4.1 Fuel systems repair facilities and areas shall: be kept clean, maintained in good repair, and be off limits to non-essential personnel. The areas and facilities shall be inspected at the start of each shift and more often as deemed necessary to ensure safe working conditions are maintained. Due to the non-standard equipment installed in some facilities, the Fuels Section Chief shall ensure operating, inspection, and maintenance instructions are available and followed for equipment installed in facilities.

3.4.2 The storage of materials or non-fuel system equipment in the maintenance area increases the risk of fire and unnecessarily complicates fire-fighting operations. Materials should be stored in equipment or tool rooms. Equipment not used for fuel system maintenance will not routinely be stored in the maintenance area. Should local conditions necessitate the use of the maintenance area for equipment storage.

3.4.2.1 Fire Department, Ground Safety, and the Fuels Section Chief will concur to the storage.

3.4.2.2 All batteries will be disconnected and terminals tagged. No batteries shall be connected or disconnected during periods of open-tank maintenance. Keys will be secured in the Element Chiefs office.

3.4.2.3 Sufficient space will remain around the aircraft to permit egress and eliminate hazards.

3.4.2.4 Equipment will not be parked within 5 foot of the shadow of the aircraft or within a 10-foot radius of fuel vents or tank openings.

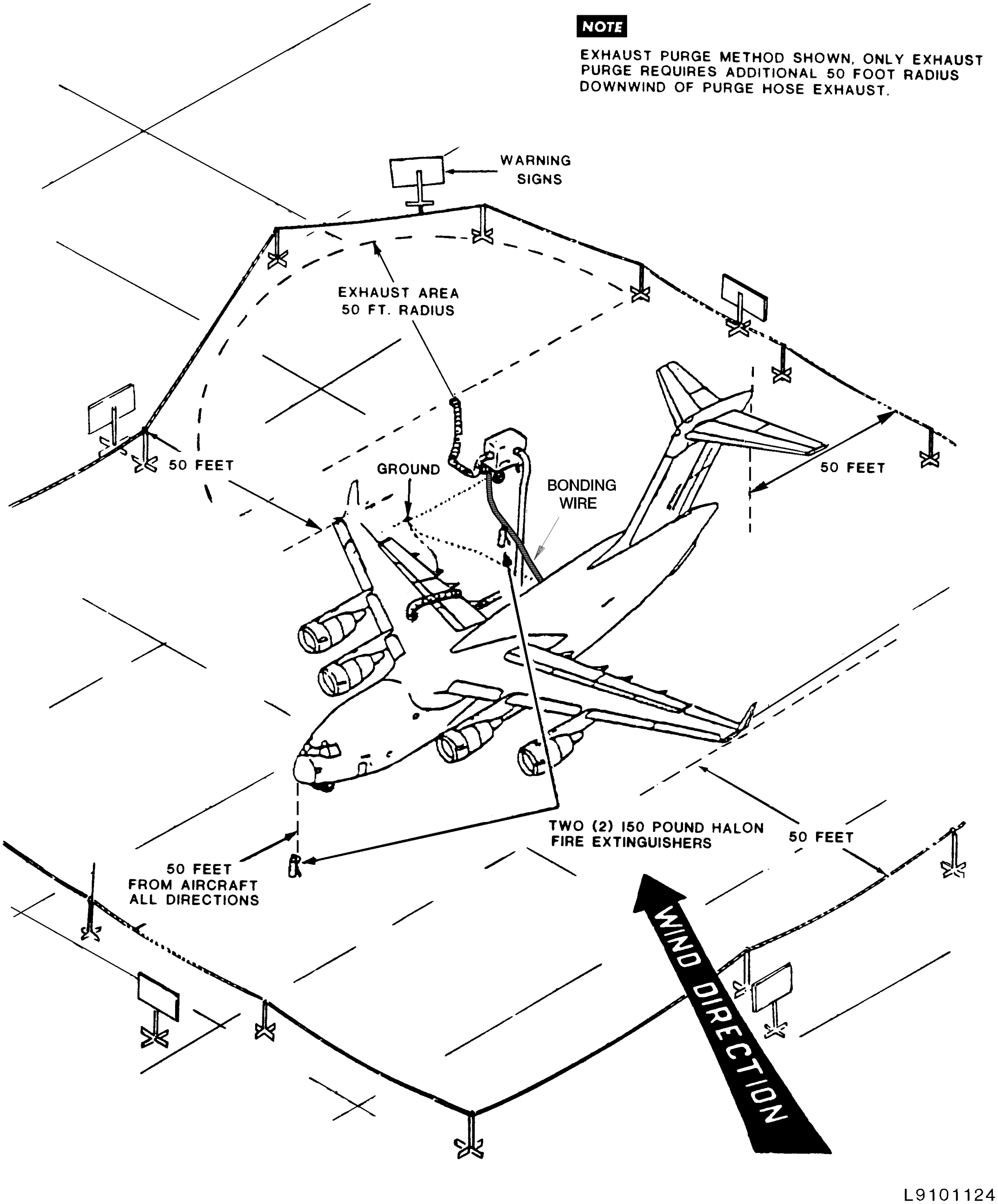


Figure 3-1. Exaust or Blow Purge Open Area Typical

CHAPTER 4
FUEL LEAK EVALUATION, CLASSIFICATION, DOCUMENTATION AND TEMPORARY REPAIRS

4.1 Purpose.

This chapter provides information on evaluating, classifying, documenting, applying temporary repairs, and removing temporary repairs to fuel leaks occurring in integral tanks.

4.2 General.

4.2.1 Fuel leaks should only be repaired when the leak threatens the airworthiness of the aircraft. Applying temporary repairs to leaks to maintain the cosmetic appearance of an aircraft is not necessary and may prove to be a labor intensive operation. As a general rule when fuel develops a leak path the fuel will travel the path of least resistance to the exterior of the aircraft. When a temporary repair is accomplished the leak path can continue to the next available exit point, at which point another temporary repair is usually accomplished. If this pattern is noted the only way to stop the leak is to apply a repair to the leak source (permanent repair).

4.2.2 Proper fuel leak evaluation and classification is necessary to determine if an aircraft is air worthy. This is accomplished by locating the leak exit point (evaluation) and monitoring the rate at which fuel is leaking from the cell or tank (classification). Possible sources for leaks are tanks, cells, ferry tanks, fuel lines, and accessories. For leakage limits and repair or replacement procedures for external tanks, ferry tanks, fuel lines and accessories refer to the system or commodity technical order. Methods approved to locate leak exit points are: talcum powder, pressure test and gas detection method. The talcum powder method has proven to be the quickest and most cost effective method for detecting leaks. The other methods are normally used when permanent repairs are required and are discussed in Chapter 6.

4.2.3 In general higher flashpoint fuels (JP-5 or JP-8) are more prone to exhibit signs of leakage. The tendency to drip becomes more pronounced at lower temperatures. For leak hazard purposes civil airline Jet A and Jet A-1 are considered equivalent to JP-8 and civil airline fuel Jet B is equivalent to JP-4.

4.3 Causes of Fuel Leaks.

Fuel leaks are caused by a variety of different reasons, all of which cause considerable expenditure of resources to correct and impact the mission capability of the aircraft. Common causes for leaks are material deficiencies, structural cracks, corrosion, improper manufacturing and maintenance procedures.

4.4 Locating Leak Exit Points.

4.4.1 Red Talcum Powder Method. After a leak has been detected and before the tank has been defueled the red talcum powder method may be used to localize a leak exit point.

4.4.1.1 Materials needed: Clean, static-free absorbent wiping cloths, marking pencil and either red leak detection talcum powder and thick bristled animal hair (example: camel or goat) brush or red aerosol leak detection talcum powder.

4.4.1.2 Procedures.

a. Strip exterior sealants from seams in suspected leak areas.

b. Blow out all seams and corners with compressed air (30 psi maximum) and wipe area dry. Change cloths as often as necessary to ensure area is completely dry.

c. Dust area with leak detection talcum powder immediately.

d. Observe dusted area in order to locate leak point. The powder which contacts fuel will turn bright red. Mark leak point with marking pencil. Continue observing and mark additional leak points.

e. Wipe remaining talcum powder, being careful not to remove leak point marks.

f. Continue leak path analysis.

Table 4-1. Leak Classification Table - Integral Fuel Tanks

LEAK CATEGORY	SIX MINUTE LEAK LIMITS BY FUEL TYPE			LOCATION - CONDITION/ACTION			
	AVGAS	JP-4	JP-5/JP-8	EXTERNAL	INTERNAL VENTED	INTERNAL NON-VENTED	ELECTRICAL CONDUIT/ EXTERNAL MOUNTED COMPONENTS
Class "A" Slow Seep	0 to 1/4 inch	0 to 1/4 inch	0 to 1/4 inch	1	1	1 (2 places)	4
Class "B" Seep	greater than 1/4 to 3/4 inch	greater than 1/4 to 3/4 inch	greater than 1/4 to 3/4 inch	1	2 (2 places max)	3	4
Class "C" Heavy Seep	greater than 3/4 to 2 inches without dripping	greater than 3/4 to 6 inches without dripping	greater than 3/4 to 8 inches and/ or less than 4 drops minute	2	3	3	4
Class "D" Running Leak	greater than 2 inches or drips or runs from surface	greater than 6 inches or drips or runs from surface	greater than 8 inches or 4 drops/minute	3	3	3	4

4.5 Integral Tank Leak Classification.

4.5.1 Each leak shall be thoroughly evaluated and the surrounding area investigated prior to classification. Wipe the area dry using a clean, static free absorbent cloth. Forced air (not to exceed 30 psi) may be used to assist drying process. Allow six minutes for leak to develop. The size of the wetted area around the leak exit point is an accurate method to classify fuel leakage. Leak detection powder may be applied to assist in classifying leaks.

4.5.2 Table 4-1 and the following shall be used for integral fuel tank leak classification:

4.5.2.1 Leak Categories. Leak categories are denoted as Class A through D. Surface irregularities may localize fuel and result in dripping even though leak is a seep or heavy seep. In such cases, judgment must be used in relating the speed with which fuel reappears and spreads after wiping to determine category of leak. When in doubt classify leak to higher leak category for repair determination.

4.5.2.2 Leak Limits. leak limits are provided for the most common Air Force aviation fuels. Mixtures of JP-4 with JP-5 and/or JP-8 shall be classified using the criteria for JP-4.

4.5.2.3 Location. Leak location is used to determine which condition/action is required.

a. External - Those areas exposed to air or airflow when flying, such as upper or lower wing surfaces and exposed fuselage surfaces. Areas that are not considered external are those surfaces exposed to airflow only when extended, such as flaps, slats etc.

b. Internal Vented - Those areas that are ventilated while flying or while the aircraft is on the ground. Examples are front and rear spars or dry bays that are drained and ventilated to the atmosphere.

c. Internal Non-Vented - Those areas that are normally adjacent to fuel tanks or fuel lines and have no means of air circulation even though they may be drained (e.g., weep holes).

d. Electrical Conduit - Conduits which route electrical wiring through fuel tanks to any components.

e. External Mounted Components. Components mounted outside a tank.

4.5.2.4 Condition/Action: The following conditions/actions are minimum requirements. Leaks, however, may always be repaired back to a no leak condition.

a. Condition 1 - Document the leak and periodically inspect for growth to condition 2 or 3. No repair is necessary, may be repaired when tank is opened for inspection or repair.

b. Condition 2 - Document and periodically inspect for growth to condition 3. No repair is required. Schedule repair when aircraft is down for maintenance, when tank is opened for inspection or repair, or in accordance with appropriate aircraft technical order.

c. Condition 3 - Document and repair to no leakage or back to condition 1 or 2 in accordance with the appropriate technical order. If leak cannot be repaired back to a condition 1 or 2 the aircraft shall be grounded until leaks are repaired.

d. Condition 4 - Do not repair by applying sealants externally or by using other temporary repair procedures. Correct discrepancy by repairing or replacing affected component. Aircraft shall be grounded until repair is complete.

4.5.3 Integral tank leaks shall be repaired using either the temporary repair methods (paragraph 4.8.) or by applying permanent repairs in accordance with Chapter 6.

4.6 Fuel Cell Leak Evaluation.

4.6.1 Any leakage from the cavity drain shall be investigated. Aircraft with fuel leaks from fuel cell cavities to adjoining dry bay(s) shall be documented and the aircraft grounded until the leak source is determined and repair action accomplished. Fuel cells shall be repaired or replaced in accordance with Chapter 7.

4.7 Documentation.

4.7.1 Any integral fuel tank leak shall be annotated on the AFTO Form 781A or 781K (manual or automated). All leaks will also be annotated in the AFTO Form 427 or 428. After a permanent repair is accomplished the AFTO Form 427 or 428 shall be maintained for a historical record. After permanent repairs are accomplished clear the entry on AFTO Form 781. Aircraft historical documents shall be consulted when fuel systems maintenance is to be performed. Documents shall accompany aircraft to depot or contractor repair or when the aircraft is transferred. Leaks and repairs shall be entered in maintenance data collection systems, e.g., CAMS, as required.

4.8 Integral Tank Temporary Repairs.

4.8.1 Temporary repairs are used to downgrade leak classifications to a flyable condition until such time permanent repairs can be accomplished. Temporary repairs should be replaced with permanent repairs when the aircraft is grounded and the tanks are opened for inspection or other maintenance. Temporary repairs are applied to the leak exit point and usually do not require tank entry. If a particular method of temporary repair repeatedly fails for a particular leak a permanent repair shall be accomplished. Suspected loose fasteners will be permanently repaired by replacing fasteners at the earliest possible date. Any leak at an interference fit fastener will be treated as a loose fastener and replaced at the earliest possible date, to ensure wing structural integrity. Temporary repairs accomplished during depot or contractor programmed depot maintenance (PDM) repair shall be removed and permanent repairs accomplished prior to release of aircraft to the using organization. Temporary repairs accomplished during delivery preparation phase of PDM shall be allowed to remain provided the repairs do not exceed one per tank.

4.8.2 The repairs of this chapter shall not be used to mask, or repair leaks caused by, structural damage, corrosion or component failure.

4.8.3 Approved methods of temporary repair, in order of preference, are:

4.8.3.1 Hardman extra-fast setting epoxy with aluminum foil patch (paragraph 4.8.4.).

4.8.3.2 Aluminum foil patch bonded with sealant (paragraph 4.8.5.).

4.8.3.3 Epoxy tabs (paragraph 4.8.6.).

4.8.3.4 Click patch (paragraph 4.8.7.).

4.8.3.5 Sealant without aluminum foil patch (paragraph 4.8.8.).

4.8.3.6 Hardman extra-fast setting epoxy without aluminum foil patch (paragraph 4.8.9.).

4.8.3.7 Comp Air D-236 injector kit (paragraph 4.8.10.).

4.8.3.8 Oylite Stik (paragraph 4.8.11.)

4.8.4 Hardman Extra-Fast Setting Epoxy with Aluminum Foil Patch.

4.8.4.1 Repair limitations/information:

a. Temperature limits -- +40°F to +120°F.

b. Curing times -- 40 minutes @ + 40°F, 15 minutes @ +120°F.

c. Humidity -- No effect.

d. Adhesion -- Epoxy adheres better to coating than to bare aluminum, therefore, do not remove coating.

e. Accelerated Cure: Heat will cause the epoxy to become brittle, therefore do not use heating devices to accelerate cure time.

f. Fuel Load -- The aircraft does not need to be defueled for this procedure.

4.8.4.2 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping cloths, Hardman Extra-fast Setting epoxy, aluminum foil patch (0.002 inch thick).

4.8.4.3 Application procedure.

a. Cut a patch from the foil that will extend 1/4-inch beyond the fastener.

b. Clean the surface of the patch to which adhesive will be applied and area around fastener with solvent.

c. Mix epoxy in accordance with manufacturer's instructions. Coat cleaned side of patch with 0.015 to 0.020 inch epoxy.

d. Press patch in place over fastener head.

4.8.4.4 Removal.

a. Using a heat gun, heat patch to 200°F to 250°F. Temperatures below 200°F will not soften epoxy. Temperatures above 250°F will damage aircraft paint system.

b. While patch is hot use a plastic scraper to pry up part of patch. Continue to apply heat and use needle-nose pliers to remove patch.

c. Reheat area and use plastic scraper to remove remaining epoxy.

4.8.5 Aluminum Foil Patch Bonded with Sealant.

4.8.5.1 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping cloths, sealant (MIL-S-8802, Class B or MIL-S-83430, Class B), aluminum foil patch (0.002 inch thick) and heat gun.

4.8.5.2 Repair limitations/information:

a. Temperature limits -- None, when heating device from kit are used.

b. Curing times -- 40 minutes @ + 140°F (temperature of heating device in repair kit).

c. Humidity -- Refer to tack free times (Table 6-2) for effect of humidity on cure times.

d. Adhesion -- At low temperatures (50°F and below), better results are obtained if area around fastener is preheated for a few minutes.

e. Accelerated Cure: Not applicable.

f. Fuel Load -- For best results the aircraft should be defueled below the leak exit point.

4.8.5.3 Application procedure.

a. Cut a patch from the foil that will extend 1/4-inch beyond the fastener.

b. Clean the surface of the patch to which adhesive will be applied and area around fastener with solvent.

c. Coat cleaned side of patch with 0.015 to 0.020 inch sealant.

d. Press patch in place over fastener head.

e. Using heating device apply heat to patch for approximately 30 minutes.

4.8.5.4 Removal.

a. Cut sealant under edge of patch with a plastic scraper.

b. Pull patch back and continue cutting until sealant and patch are removed.

4.8.6 Epoxy Tabs or Putty.

4.8.6.1 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping cloths, epoxy putty or epoxy tab Type-O.

4.8.6.2 Repair limitations/information:

a. Temperature limits - None.

b. Curing times -- Approximately two minutes.

c. Humidity -- No limitations.

d. Adhesion -- Scuff sanding may help adhesion.

e. Accelerated Cure: Not applicable.

f. Fuel Load -- The aircraft does not need to be defueled for this procedure.

4.8.6.3 Application procedure.

a. Clean the area around fastener with solvent.

b. Mix epoxy according to manufacturer's instructions.

c. Apply ample amount epoxy over fastener. Feather edges to approximately 1/4-inch beyond edge of fastener. Remove excess epoxy.

4.8.6.4 Removal.

a. Place a plastic scraper at edge of repair.

b. Tap scraper with rubber mallet until repair pops off.

4.8.7 Click Patch.

4.8.7.1 Materials required: Click patch kit.

4.8.7.2 Repair limitations/information:

a. Temperature limits -- Refer to information for type of adhesive used.

b. Curing times -- Refer to information for type of adhesive used.

c. Humidity -- Refer to information for type of adhesive used.

d. Adhesion -- Refer to information for type of adhesive used.

e. Accelerated Cure-- Refer to information for type of adhesive used.

f. Fuel Load -- The aircraft does not need to be defueled for this procedure.

4.8.7.3 Application procedure. Use contents of kit in accordance with manufacturer's instructions.

4.8.7.4 Removal.

a. For sealant adhesive type patches:

(1) Cut sealant under edge of patch with a plastic scraper.

(2) Pull patch back and continue cutting until sealant and patch are removed.

b. For epoxy adhesive type patches:

(1) Using a heat gun, heat patch to 200°F to 250°F. Temperatures below 200°F will not soften epoxy. Temperatures above 250°F will damage aircraft paint system.

(2) While patch is hot use a plastic scraper to pry up part of patch. Continue to apply heat and use needle-nose pliers to remove patch.

(3) Reheat area and use plastic scraper to remove remaining epoxy.

4.8.8 Sealant Without Aluminum Foil Patch.

4.8.8.1 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping cloths, sealant (MIL-S-8802, Class B, or MIL-S-83430, Class B), and heat gun.

4.8.8.2 Repair limitations/information:

a. Temperature limits -- None, when heating device from kit are used.

b. Curing times -- 40 minutes @ + 140°F (temperature of heating device in repair kit).

c. Humidity -- Refer to tack free times (Table 6-2) for effect of humidity on cure times.

d. Adhesion -- At low temperatures (50°F and below), better results are obtained if area around leak exit point is preheated for a few minutes.

e. Accelerated Cure: Not applicable.

f. Fuel Load -- For best results the aircraft should be defueled below the leak exit point.

g. Other Limits -- This method should only be used on non-pressurized fuel tank surfaces.

4.8.8.3 Application procedure.

a. Clean the surface of which sealant will be applied.

b. Apply a thin coat of sealant to leak exit point.

c. Using heating device apply heat for approximately 30 minutes.

4.8.8.4 Removal. Cut sealant off with a plastic scraper.

4.8.9 Hardman Extra-Fast Setting Epoxy Without Aluminum Foil Patch.

4.8.9.1 Repair limitations/information:

a. Temperature limits -- +40°F to +120°F.

b. Curing times -- 40 minutes @ + 40°F, 15 minutes @ +120°F.

c. Humidity -- No effect.

d. Adhesion -- Epoxy adheres better to coating than to bare aluminum, therefore, do not remove coating.

e. Accelerated Cure: Heat will cause the epoxy to become brittle, therefore do not use heating devices to accelerate cure time.

f. Fuel Load -- For best result defuel aircraft below leak exit point.

g. Other Limits -- This method should only be used on non-pressurized fuel tank surfaces.

4.8.9.2 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping cloths, Hardman Extra-fast Setting epoxy.

4.8.9.3 Application procedure.

a. Clean the area to which adhesive will be applied with solvent.

b. Mix epoxy in accordance with manufacturer's instructions.

c. Apply a thin coat of epoxy to leak exit point.

4.8.9.4 Removal.

a. Using a heat gun, heat epoxy to 200°F to 250°F. Temperatures below 200°F will not soften epoxy. Temperatures above 250°F will damage aircraft paint system.

b. While epoxy is hot use a plastic scraper to remove epoxy.

4.8.10 Comp Air D236 Injector Kit. The injector forces sealant into the leaks at 900 psi.

4.8.10.1 Repair limitations/information:

a. Temperature limits -- None.

b. Curing times -- Five to 10 minutes @ 150°F.

c. Humidity -- Humidity does not effect cure time.

d. Adhesion -- Paint must be removed from around leaking fastener.

e. Accelerated Cure -- Not applicable.

f. Fuel Load -- The aircraft does not need to be defueled for this procedure.

g. Other Limits -- For use on leaks around flush type fasteners.

4.8.10.2 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping clothes, Comp Air D236 Injector Kit, sealant (MIL-S-22437), aluminum foil tape.

4.8.10.3 Application procedure.

a. For leaks on lower wing surfaces:

(1) Preheat D236-14 heating iron to 150°F maximum. Remove paint from around fastener and clean with solvent.

(2) Position locator D236-12-2 overhead of fastener and attach with suction cups.

(3) Attach D236-11 cylinder and D236-10 jack. Use extensions as necessary.

(4) Align complete assembly to be perpendicular to surface.

(5) Attached compressed air source to cylinder.

(6) Fill injector with sealant.

(7) Place injector through locator.

(8) Manually extend jack to force cylinder rod to retract into cylinder approximately three inches.

(9) Observe injector head. When all sealant has been injected the sleeve will line up with edge of body.

(10) Remove injector, wipe surface with cloth dampened with solvent.

(11) Apply aluminum foil tape, approximately one inch square, over fastener head.

(12) Hold heating iron firmly against tape for 5 to 10 minutes to cure sealant.

(13) Peel tape off.

b. For leaks on upper wing surfaces. Preheat D236-14 heating iron to 150°F maximum. Remove paint from around fastener and clean with solvent.

(1) Place correct foot assembly over leak.

(2) Position locator D236-12-3.

(3) Fill foot with sealant.

(4) Install plunger in foot assembly.

(5) Press down on plunger to inject sealant.

(6) Remove injector, wipe surface with cloth dampened with solvent.

(7) Apply aluminum foil tape, approximately one inch square, over fastener head.

(8) Hold heating iron firmly against tape for 5 to 10 minutes to cure sealant.

4.8.10.4 Removal. Remove when final repairs are accomplished.

4.8.11 Oyltite Stik.

4.8.11.1 Repair limitations/information:

a. Temperature limits -- None.

b. Curing times -- Immediate.

c. Humidity -- Humidity does not effect cure time.

d. Adhesion -- Not applicable.

e. Accelerated Cure: Not applicable.

f. Fuel Load -- The aircraft does not need to be defueled for this procedure.

g. Additional Limitations. For use on leaking fasteners. May require touch-up paint after application.

4.8.11.2 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Chapter 8), clean, static-free absorbent wiping cloths, Oyltite Stik.

4.8.11.3 Application procedure.

a. Clean area with solvent.

b. Soften Oyltite Stik by dipping open end in solvent.

c. Firmly apply Oyltite Stik to fastener head. Repeat as necessary.

d. Remove excess material.

4.8.11.4 Removal. Remove when permanent repairs are accomplished.

CHAPTER 5
PREPARATION FOR MAINTENANCE

5.1 PURPOSE.

WARNING

Aircraft purging, depuddling and inerting require that extreme precautions be taken to prevent fire, explosions or health hazards. Strict compliance with the safety and health requirements, instructions and checklist in Chapter 2 of this manual are mandatory.

This chapter provides instructions for preparing aircraft fuel tanks for maintenance and/or inspection.

5.2 GENERAL.

5.2.1 Descriptions and procedures for purging, depuddling, and inerting of aircraft fuel cells/tanks, with or without explosion suppression foam materials and the equipment/materials required to accomplish these tasks are described. Purging and depuddling may be accomplished in any Category III facility or fuel system maintenance area. Aircraft fueling/defueling, and mooring, shall be accomplished in accordance the applicable aircraft manual. Electrical, egress, armament and other systems shall be made safe in accordance with Chapter 2 of this manual, the applicable aircraft manuals, and other general series manuals. Grounding and bonding shall be in accordance with Chapter 2.

5.2.2 Aircraft, serviced with AVGAS or JP-4, requiring defueling, should be defueled prior to being towed into any fuel system repair facility. Fuel may be transferred between internal tanks to facilitate maintenance requirements; drained, depuddled or air purged when the aircraft is in open fuel system repair areas or Category III facilities.

5.3 PURGING METHODS.

5.3.1 General.

5.3.1.1 Purging is used to remove volatile fuel vapors from a cell/tank and reduce the LEL while maintaining an acceptable percentage of oxygen in the tank. The two approved methods for purging are fluid purge and air purge. Aircraft which use JP-5 or JP-8 may not, under certain circumstances, require purging and can have the LEL maintained at acceptable levels by ventilating the tank. Purging to an entry-safe condition (10% LEL or (600 ppm) (20% LEL or (1200 ppm) for foam removal) or less) shall be attained prior to performing in-tank maintenance or inspections. If entry is not required the tank need only be purged to maintain a fire-safe condition (20 percent LEL). Tanks shall be continuously purged or ventilated during all entries unless the tank can be maintained below 10% LEL or (600 ppm) without any ventilation.

5.3.1.2 Fluid Purge. Fluid purge is flushing a fuel system with a fluid to remove flammable fuels which remain after defueling. Purging fluid MIL-F-38299 or jet fuel JP-5 or JP-8 may be used. All purge fluids shall maintain a minimum 120°F flashpoint. Aircraft serviced with JP-8 may require a fluid purge, with one of the other approved purge fluids, or an air purge if the proper flashpoint can not be achieved/maintained. Typically if the temperature is above 75°F and the flashpoint of the JP-8 is 100°F the LEL may not remain below 20 percent at standard atmospheric pressures. When fluid purging it is not necessary to open access doors or other fittings. Continuous mechanical ventilation is required during all entries.

5.3.1.3 Air Purge. Air purge is the process of supplying fresh air to or exhausting air from a fuel tank to reduce fuel vapors concentration. Three approved types of air purge are combination, blow, and exhaust purge. The preferred method of air purge is a combination exhaust and blow purge. Exhaust purge is the process of exhausting the tank air (to a safe area) and pulling fresh air into the tank. Blow purge is the circulating (blowing) of fresh air into a tank. Air purge may be accomplished with installed and/or portable equipment. Air purge shall be continuous during all entries.

5.3.1.4 Ventilation. Ventilation is the process of supplying fresh air to or exhausting air from a fuel tank once a tank is considered acceptably purged.

5.4 AIR PURGE PROCEDURES.

NOTE

Combination exhaust and blow is the preferred method for air purge operations. A closed purge system will improve the aircraft purge process. To obtain a closed purge system the fabrication of a local manufactured adapter plate is required. Unit shall follow established local manufacture procedures.

5.4.1 Combination Exhaust and Blow Purge Procedures.

5.4.1.1 Equipment and Materials Required. Equipment to defuel aircraft, safety streamers, air movers, air ducts, air compressor, safety containers, bowsers, combustible vapor meter.

5.4.1.2 Procedures.

a. Defuel aircraft in accordance with applicable manual.

b. Opens sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank that contained JP-8 may not remain under 20 percent if the ambient temperature exceeds 75°F at standard atmospheric pressures. If it is expected the temperature will exceed 75°F the tank should be purged with another fluid or air purged.

c. For open areas place the blower or HDU-13/M heater convenient to the aircraft. Blower or heater shall be bonded in accordance with Chapter 2.

d. Attach blow purge ducts to the inlet side of the blower and extend to the aircraft.

e. Bond the ducts to the aircraft. Bonding wire may be at the end or at the first section from the end.

CAUTION

To prevent damage to the aircraft make sure all vents and filler caps are open before starting blower.

f. Start the air mover and blower prior to opening fuel tank access doors.

g. Remove access doors or panels. Ensure at least one access door or panel is removed in addition to the opening where the exhaust duct will be placed. Take care to prevent damage to doors, panels and aircraft. Tilt the door inward to avoid fuel spillage.

WARNING

To prevent possibility of fire or explosion, the blower must be turned on prior to connecting air ducts to the aircraft. If power fails, immediately remove the air duct from the aircraft and move the air duct and blower to an area free from fuel fumes. Failure to comply with this procedure could result in injury or death to personnel and damage to or destruction of the aircraft.

h. Install exhaust and blow ducts in opening. Refer to Figure 5-1 for typical duct routing.

i. Purge for 30 minutes. If needed, after 15 minutes, move the duct to a different position to complete the purge.

j. Remove exhaust duct from opening. Do not turn blower off until purge procedure is complete.

k. Check oxygen level in tank. If oxygen level is not between 19 and 23.5 percent repeat purge procedure.

l. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure for 15 minutes. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is fire safe. If LEL is less than 10 percent the aircraft is entry safe.

m. Depuddle tanks as necessary. Maintain air purge and comply with all requirements of the entry permit during entry.

n. For hangared non-foamed aircraft the LEL shall be checked every four hours or more often as deemed necessary to assure a fire safe condition is maintained. Normally a LEL check will be made at the beginning of each shift. When working in a foam equipped aircraft the LEL shall be checked using a continuous monitoring combustible meter or checked every two minutes using a non-continuous meter. Readings will be taken at the entry point and progressively to the furthest point at which maintenance operations extend inside the tank. After all foam is removed the tank should be considered a non-foamed tank.

5.4.2 Exhaust Purge Procedures.

5.4.2.1 Equipment and Materials Required. Equipment to defuel aircraft, safety streamers, air movers, air ducts, air compressor, safety containers, bowsers, combustible vapor meter.

5.4.2.2 Procedures.

a. Defuel aircraft in accordance with applicable manual.

b. Opens sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank that contained JP-8 may not remain under 20 percent if the ambient temperature exceeds 75°F at standard atmospheric pressures. If it is expected the temperature will exceed 75°F the tank should be purged with another fluid or air purged.

c. For open areas place the blower or HDU-13/M heater convenient to the aircraft. Blower or heater shall be bonded accordance with Chapter 2.

d. Attach exhaust purge ducts to the inlet side of the blower and extend to the aircraft.

e. Bond the ducts to the aircraft. Bonding wire may be at the end or at the first section from the end.

CAUTION

If necessary, to prevent damage to the aircraft, make sure all vents and filler caps are open before starting blower.

f. Start the air mover and blower prior to opening fuel tank access doors.

g. Remove access doors, or panels. Take care to prevent damage to doors, panels and aircraft. Tilt door inward to prevent fuel spillage. Perform an IPI prior to closing/securing any fuel tank access door, ref: AFI 21-101 and T.O. 00-20-5.

WARNING

To prevent possibility of fire or explosion, the blower must be turned on prior to connecting air ducts to the aircraft. If power fails, immediately remove the air duct from the aircraft and move the air duct and blower to an area free from fuel vapors. Failure to comply with this procedure could result in injury or death to personnel and damage to or destruction of the aircraft.

h. Install exhaust duct in opening.

i. Purge for 30 minutes. If needed, after 15 minutes, move the duct to a different position to complete the purge.

j. Remove exhaust duct from opening. Do not turn blower off until purge procedure is complete.

k. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.

l. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure for 15 minutes. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is fire safe. If LEL is less than 10 percent the aircraft is entry safe.

m. Depuddle tanks as necessary. Maintain air purge and comply with all requirements of the entry permit during entry.

n. For hangared non foamed aircraft the LEL shall be checked every four hours or more often as deemed necessary to assure a fire safe condition is maintained. Normally a LEL check will be made at the beginning of each shift. When working in a foam equipped aircraft the LEL shall be checked using a continuous monitoring combustible meter or checked every two minutes using a non-continuous meter. Readings will be taken at the entry point and progressively to the furthest point at which maintenance operations extend inside the tank. After all foam is removed the tank should be considered a non-foamed tank.

5.4.3 Blow Purge Procedures.

5.4.3.1 Equipment and Materials Required. Equipment to defuel aircraft, safety streamers, air movers, air ducts, air compressor, safety containers, bowsers, combustible vapor meter.

5.4.3.2 Procedures.

a. Defuel aircraft in accordance with applicable manual.

b. Opens sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank that contained JP-8 may not remain under 20 percent if the ambient temperature exceeds 75°F at standard atmospheric pressures. If it is expected the temperature will exceed 75°F the tank should be purged with another fluid or air purged.

c. For open areas place the blower or HDU-13/M heater convenient to the aircraft. Blower and heaters shall be bonded in accordance with Chapter 2.

d. Attach blow purge ducts to the outlet side of the blower.

e. Start the air mover and blower prior to opening fuel tank access doors (if used).

f. Bond the ducts to the aircraft. Bonding wire may be at the end or at the first section from the end.

g. Remove access doors. Ensure at least one access door or panel is removed in addition to the opening where the duct will be placed. Take care to prevent damage to door and aircraft. Tilt the door inward to prevent fuel spillage.

WARNING

To prevent possibility of fire or explosion, the blower must be turned on prior to connecting air ducts to the aircraft. If power fails, immediately remove the air duct from the aircraft and move the air duct and blower to an area free from fuel vapors. Failure to comply with this procedure could result in injury or death to personnel and damage to or destruction of the aircraft.

h. Install blower duct in door opening.

i. Purge for 30 minutes.

j. Remove blower duct from opening. Do not turn blower off until purge procedure is complete.

k. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.

l. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure for 15 minutes. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is fire safe. If LEL is less than 10 percent the aircraft is entry safe.

m. Depuddle tanks as necessary. Maintain blow purge and comply with all requirements of the entry permit during entry.

n. For hangared non foamed aircraft the LEL shall be checked every four hours or more often as deemed necessary to assure a fire safe condition is maintained. Normally a LEL check will be made at the beginning of each shift. When working in a foam equipped aircraft the LEL shall be checked using a continuous monitoring combustible meter or checked every two minutes using a non-continuous meter. Readings will be taken at the entry point and progressively to the furthest point at which maintenance operations extend inside the tank. After all foam is removed the tank should be considered a non-foamed tank.

5.5 EXPLOSION SUPPRESSION FOAM MATERIALS (FUEL FOAM).

5.5.1 General. The Air Force uses foam materials specification MIL-B-83054 and MIL-F-87260. Fuel foam materials: suppress explosive reactions; control ignition rate of burning fuel vapors; and act as a baffle to limit fuel sloshing. Fuel tanks containing fuel foam will not explode when pierced by ground fire or when subjected to electrical arcs from failed components or as the result of lightning.

5.5.2 MIL-B-83054 Fuel Foam Material. Foam meeting specification MIL-B-83054, is generally referred to by type or color and include the following: Type I (orange), Type II (yellow), Type III (red), Type IV (dark blue), and Type V (light blue). Types I, II, and III are susceptible to deterioration from exposure to high temperature, humidity and have a service life of from two to seven years. Types IV and V have better resistance to temperature, humidity and have a longer service life. MIL-B-83054 foam materials are not electrically conductive and can develop an electrical potential during certain fuel servicing operations or flight profiles. These static charges can discharge and cause singeing or burning. Types IV and V have a higher volume swell and lower tensile strength and tear resistance, therefore, it is important that these types be carefully sized and properly installed with adequate clearances. Type I, II and IV are coarse pore foams. Types III, and V are fine pore foams. Fine and coarse pore foams are not interchangeable.

5.5.3 MIL-F-87260 Fuel Foam Material. Foam meeting specification MIL-F-87260 may be any color except orange, yellow, red, or blue. Generally the foam material is gray or black in color. Foam materials meeting specification MIL-F-87260 are electrically conductive and will not hold a static electricity charge. The foam is separated into two classes, each containing two grades of foam. Class 1 foam has a temperature range of 0°F to +160°F, Class 2 material has a temperature range of -30°F to +160°F. Grade IC foam is coarse pore material. Grade IIC foam is a fine pore material. Fine and coarse pore foams are not interchangeable. These foams have some tolerance to humidity.

5.5.4 Foam Removal Procedures.

5.5.4.1 Requirements for open tank maintenance and in-tank maintenance apply as necessary.

5.5.4.2 Defuel aircraft as necessary.

5.5.4.3 Drain sumps and drains as necessary.

5.5.4.4 Purge and enter tanks, as necessary.

CAUTION

Fuel wetted foam tears easily. Exercise care when removing reticulating foam pieces from the fuel tank.

5.5.4.5 Slowly remove foam to minimize static electricity buildup. Use care to prevent tearing foam. Remove only the foam necessary to accomplish the inspection/repair.

5.5.4.6 Depuddle as necessary.

5.5.5 Foam Inspection Criteria. After removal and before storage foam shall be inspected for the following.

NOTE

Do not pull test fuel wetted foam. Fuel wetted foam tears easily.

5.5.5.1 Legibility of Marking.

5.5.5.2 If markings are not legible, identify and use a fuel resistant marker to mark with proper alphanumeric combination in accordance with the aircraft technical order.

5.5.5.3 Cleanliness or Contamination. Examine for foreign particle such as lint or fibers. Remove contamination either by hand or with an approved vacuum cleaner. Replace excessively contaminated foam or foam which cannot be cleaned. Foam in low areas of tank will have a tendency to collect higher concentrations of foreign particles.

5.5.5.4 Burning or Singeing. Examine for burning or singeing. Replace damaged foam. Normal indication of damage are surface color changes, formation of rough bead-like surface, excessive gorging in foam pattern or areas of stickiness. The most likely areas to find evidence of burned or singed foam are tank vent outlets and inlets.

5.5.5.5 Deterioration. Examine foam for loose particles or pull on a few foam strands, if foam has loose particles or strands tear easily replace foam. The most likely areas to fine deterioration are in the upper areas near the vents.

5.5.5.6 Tears or Punctures. Examine for tears or punctures, excessively damaged foam shall be replaced.

5.5.6 Replacement of Foam. Foam may be either ordered from supply in bulk or pre-cut kits. Foam can be cut with a sharp electric knife, Ontario knife, or a band saw with self-cleaning blade. The electric or Ontario knife is best for cutting small quantities or individual replacement pieces of foam. Replacement foam must be cut identical in form. Mark replacement foam with proper alphanumeric identifier.

5.5.7 Reinstallation of Foam. Proper reinstallation of foam is extremely important. Voids designed into the foam provide clearances around fuel systems components such as vents, pumps, probes and interconnects. If 25 percent or more of the foam has been removed from any one tank and reinstalled or replaced the tank must be flushed with clean filtered fuel to remove contamination. A minimum of one fill and drain shall be accomplished with sump sample taken. Sample shall be tested for solids contamination in accordance with TO 42B-1-1. Acceptable increase in solids contamination is 2 mg/gal over that serviced to the aircraft during filling. Emphasis should be placed on draining tank sumps and on periodic checking of fuel strainers. After reinstallation or replacement of foam around a component, interconnect or vent accomplish functional testing of the fuel system. The testing will include all safety of flight items and may be performed during the fill and drain contamination test.

5.6 DEPUDDLING.

5.6.1 General. Depuddling is the removal of residual fuel or purgefluid which remain after the tanks are drained. Depuddling may be accomplished by using absorbent cloths, sponges, mops and approved safety container or an approved air operated vacuum. All fuel puddles in the path of air flow or where work will be accomplished will be removed.

5.6.2 Equipment an Materials Required. Equipment to defuel aircraft, sponges, absorbent cloths, safety container, mop, equipment to purge aircraft, air operated vacuum cleaner.

5.6.3 Depuddling Procedures.

5.6.3.1 Requirements for open tank maintenance and in-tank maintenance apply as necessary.

5.6.3.2 Defuel aircraft fuel tanks as necessary.

5.6.3.3 Drain sumps and drains as necessary.

5.6.3.4 Purge and enter tanks as necessary.

5.6.3.5 Remove fuel foam as necessary.

5.6.3.6 Use cloth, sponge, mop, and approved safety container or air-operated vacuum to remove fuel puddles.

5.7 INERTING.

5.7.1 General. Inerting is the replacement of oxygen in air or air-fuel mixture with an inert gas to the point that the oxygen content is too low to support combustion. Nitrogen is the gas most commonly used to inert AF aircraft fuel tanks. Carbon dioxide can be used but is not preferred due to its high solubility in fuel. Inerting may be used to safeguard a tank during hot work. Inerting may also be used to safeguard adjacent tanks. The two approved methods of inerting are pressure inerting and siphon inerting.

5.7.2 Requirements.

5.7.2.1 Measurement of Gas Concentration. The concentration of inert gas is not a direct measurement of inerting gas but it is a measured as a percentage of oxygen remaining in the atmosphere. An approved oxygen analyzer shall be used to measure the oxygen content of the atmosphere in the tank.

5.7.2.2 Inert Gas Concentration. The oxygen content of a tank shall be maintained at nine percent or less for siphon inerting and four percent or less for pressure inerting. Once a tank is inerted it shall remain inerted until repairs are complete. A positive inert gas pressure should be maintained on the inerted tank.

5.7.2.3 Certifying Inerted Tanks. Inerted tanks shall be certified by a qualified fuel system repairer. For tanks in work, tanks shall be retested at the start of every shift, periodic intervals not to exceed four hours or more often as deemed necessary. For tanks on aircraft not in work the tank shall be retreated daily. Periodic checks shall be accomplished to ensure an inert atmosphere is maintained. Special consideration shall be given to retesting and assuring the inert atmosphere in nonmetallic fuel cells.

5.8 SIPHON INERTING.

5.8.1 General. Siphon inerting is when an aircraft fuel tank is filled to capacity with fuel and then drained with an inert gas siphoned into the tank void spaces. Siphon inerting is considered the most efficient procedure for inerting interconnected tanks in that this procedure assures an even distribution of inert gases throughout a fuel tank system.

5.8.2 Equipment and Materials Required: Inert gas supply, surge tank, differential pressure gauge, tubing, oxygen analyzer, equipment to defuel aircraft, safety streamers, fuel servicing truck.

5.8.3 Siphon Inerting Procedures. Assemble equipment as shown in Figure 5-3.

5.8.3.1 Fill aircraft to capacity with fuel.

5.8.3.2 Open pressure valve, set gas pressure to between 1 and 1½ pounds/inch^2

5.8.3.3 Open gas needle valve to allow gas to inert surge tank and connecting lines.

5.8.3.4 Conduct a static pressure test to ensure integrity of system.

5.8.3.5 Connect inert gas line to fuel vent opening. Ensure connection is air tight.

5.8.3.6 Defuel aircraft while opening needle gas to inert gas line. Line shall be opened enough to provide a continuous supply of gas and prevent collapse of tank.

5.8.3.7 Maintain positive pressure between 1 and 1½ pounds/inch^2. Ensure maximum safe working pressure is not exceeded.

5.8.3.8 After drain is complete it is preferred that equipment remain installed and a slight positive pressure be maintained. Nitrogen quantity shall be renewed as necessary. If inert gas supply is depleted the tank shall be considered un-inert and the oxygen content shall be determined. Reaccomplish inerting procedures if necessary. The inert gas supply line may be disconnected at the surge tank inlet and capped off. If this is done oxygen content must be monitored to insure tank does not become un-inert due to thermal contraction.

5.9 PRESSURE INERTING.

5.9.1 General. Pressure inerting is the processes of placing an inert gas under pressure into the vapor space of a fuel tank. Pressure inerting works best on single tanks whether integral, mounted on, or removed from an aircraft. Pressure inerted tanks shall be thoroughly tested to ensure the entire vapor space is sufficiently inert.

5.9.2 Equipment and Materials Required. Inert gas supply, pressure regulator, needle-type control valve, tubing with bonding wire, pressure relief valve, gas tight fitting for filler neck, safety streamer, oxygen analyzer.

5.9.3 Pressure Inerting Procedures. Assemble equipment as shown in Figure 5-2.

5.9.3.1 Install gas tight fitting on tubing.

5.9.3.2 Ensure bond wire has continuity from gas source to fitting.

5.9.3.3 Ground pressure inerting equipment.

5.9.3.4 Clear moisture and dust from inert gas delivery system by discharging a small amount of gas.

5.9.3.5 Connect bond wire from inert gas delivery system to aircraft or tank.

5.9.3.6 Connect gas tight fitting to fuel tank filler assembly. Ensure integrity of gas tight seal.

5.9.3.7 Adjust inert gas pressure regulator to proper level.

5.9.3.8 Open needle valve. Check pressure relief valve. If gas is discharging, reduce needle valve opening until discharge stops.

5.9.3.9 Continue flow until inert atmosphere is obtained. Thoroughly probe all areas of tank to ensure tank is inert.

5.9.3.10 Close off vent line openings with gas tight plug or seal.

5.9.3.11 Remove gas tight fitting from fuel tank opening and cover with safety seal or leave equipment in place.

5.9.3.12 Tank shall remain inerted until repairs are complete.

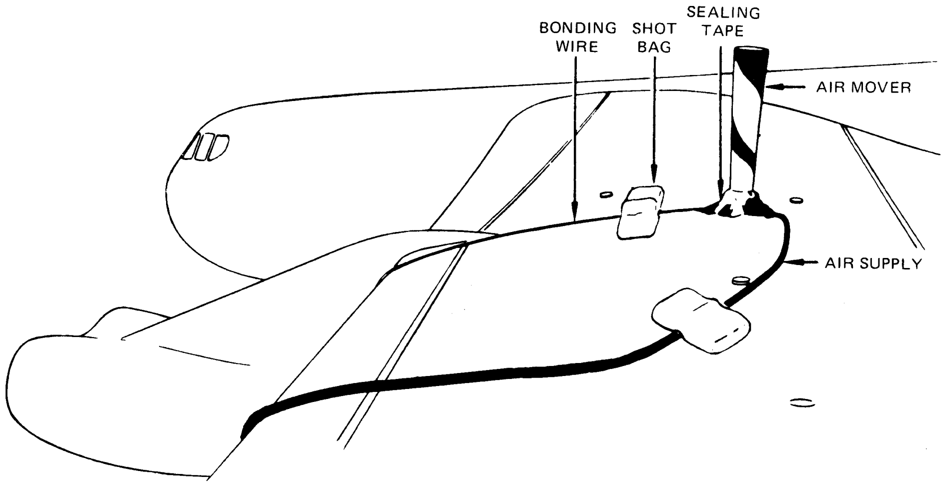


Figure 5-1. Air Mover Installation

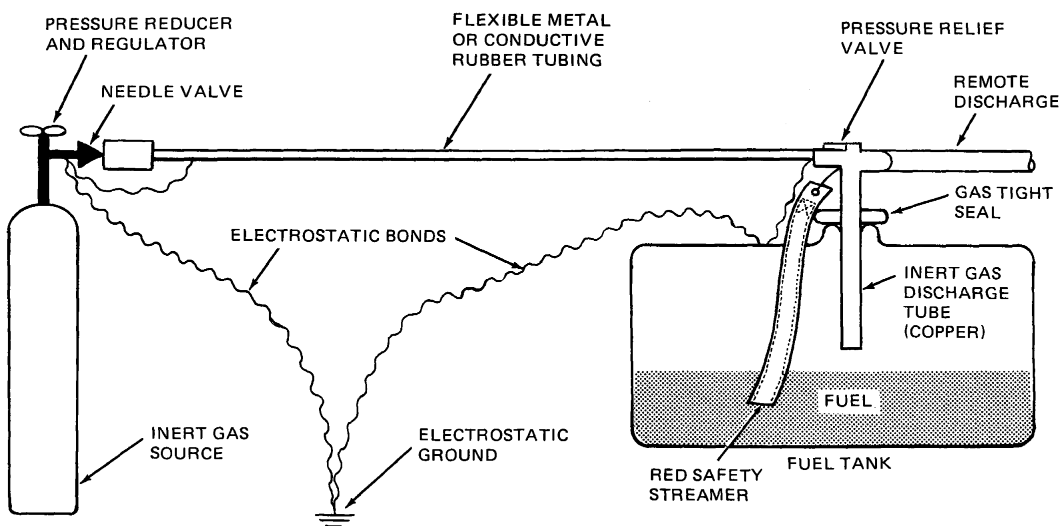


Figure 5-2. Schematic Diagram of Pressure Inerting

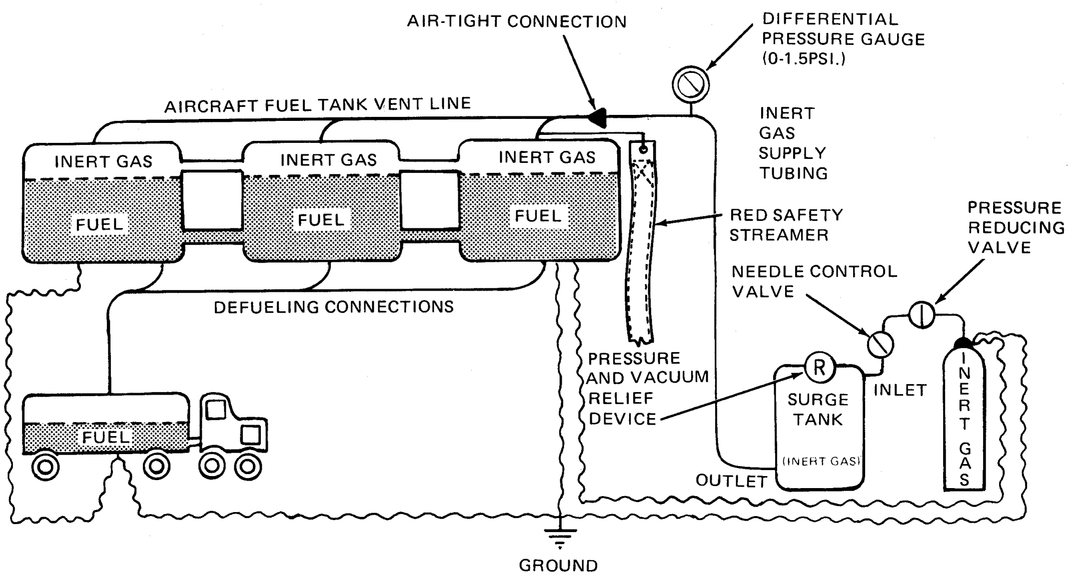


Figure 5-3. Schematic Diagram of Siphon Inerting

CHAPTER 6
INTEGRAL TANKS

6.1 PURPOSE.

This chapter provides additional information on locating fuel leaks and applying permanent repairs to fuel leaks occurring in integral tanks.

6.2 GENERAL.

6.2.1 Integral tanks were developed because they offered the capability of greater fuel containment with a decrease in weight over fuel cell type construction. The tanks are designed with a seal plane, which has been sealed with gaskets, structural adhesives, elastic films or other sealants. Integral tanks have been built into both the wing and fuselage sections of an aircraft with the primary structure forming the boundaries of the tank.

6.2.2 The leak detection methods described in this chapter are more involved than the methods described in Chapter 4. The methods described in this chapter should be used prior to initiating permanent repairs.

6.2.3 ALC maintenance activities should consult the aircraft documents and remove all temporary repairs, external fastener repairs, and repair the aircraft in accordance with this chapter or aircraft specific weapon system manuals.

6.3 FUEL LEAKS.

6.3.1 Leak Path Analysis. Planning is extremely important in locating fuel leak paths. The procedures for locating fuel leaks shall be closely followed. The following sequence should be used to locate leaks:

6.3.1.1 Determine the exact exit points using one of the approved methods (of this manual).

6.3.1.2 Isolate leak to proper tank.

6.3.1.3 Using aircraft technical manuals, analyze leak paths.

6.3.1.4 Using approved methods (of this manual) to determine leak source.

6.3.2 Determining which Tank is Leaking. Fuel leaks which appear near the common boundary of two adjacent tanks may originate in either tank. One method to isolate the leaking tank is to use the following procedures:

6.3.2.1 Transfer/defuel one of the tanks normally the outboard tank.

6.3.2.2 Allow time for fuel to drain and check for leak. If leak has stopped, the tank which just had the fuel removed was the leaking tank.

6.3.2.3 If tank is still leaking transfer fuel to other tank.

6.3.2.4 Allow time for fuel to drain. If leak has stopped, the tank which just had the fuel removed was the leaking tank.

6.3.2.5 If leak continues either both tanks are leaking or residual fuel is giving the indication. If residual fuel is suspected perform the following.

6.3.2.6 Transfer/defuel both tanks and drain residual fuel.

6.3.2.7 Fuel one tank, if no indication appears, the other tank is the leaker. If leak is indicated continue.

6.3.2.8 Transfer/defuel the fueled tank, wait for leak to stop, fuel the other tank. If a leak is indicated, both tanks leak.

6.4 LEAK EXIT POINT DETECTION.

6.4.1 Pressure Test.

6.4.1.1 General. If previous efforts to locate a leak exit point have been unsuccessful or other methods to locate a leak appear impractical a pressure test may be used to locate leak exit points. A pressure test is effective in locating leaks which appear only under stress, in-flight leaks, confirming repair work prior to refueling, or when a tank has multiple leaks. The pressure test requires extensive preparation. Extreme care must be taken during the preparation and execution of the test to prevent damaging the aircraft. Particular attention must be given to the aircraft vent systems and specified pressure limits of the applicable tank. A water manometer shall be used as a pressure limiting device. In addition to entries on the AFTO Form 781A, a checklist shall be developed to ensure all plugs, cover plates, and caps are removed. These procedures require two personnel, one shall be stationed at the tank access adapter and shall monitor manometer the other shall locate and mark leak exit points.

6.4.1.2 Materials and Equipment Required. Water manometer, access door adapter (with manual shutoff valve, positive and negative pressure relief valves), caps, cover plates, plugs, safety streamers, equipment to defuel and purge tanks, air supply, non-corrosive leak detection compound, marking pencil, solvent or aircraft cleaning compound and water.

6.4.1.3 Procedures. Refer to the aircraft technical manuals for specific guidance. General procedures are as follows:

a. Defuel and purge tanks as necessary.

b. Install plates, caps, and plugs as required to all fittings. Ensure cables are attached to door cover.

c. Attach air supply to manometer.

d. Pressurize tank to maximum allowable air pressure (refer to aircraft specific TOs). Additional pressure will not aid in leak detection.

e. Apply leak detection compound to tank exterior. Spread the leak detection compound with a brush. Observe tank for formation of bubbles.

f. Mark leak exit points.

g. Within 24 hours wash leak detection compound from aircraft.

6.4.2 Development of Leak Path Analysis. Develop a leak path analysis for each leak exit point. Thoroughly analyze the area and structure around the leak exit point for all possible leak paths and sources. When investigating the location and cause of a fuel leak in the fuel tank boundary structure, keep in mind the fuel leak may be caused by a structural failure. Fuel can leak through an almost invisible crack in the structure. When a leak occurs, structural failure should be considered as a possible cause.

6.4.3 Inspection of Tank Interior. A thorough investigation of the area surrounding the leak exit can help isolate the leak source. Study the structure in the leak area and the direction from which the leak seems to be flowing. Visible defects in the sealant or structure are not necessarily the leak source. Structural failures shall not be repaired by applying sealant to the failed area. An inspection checklist may be helpful. The following are common items to check when performing a visual inspection of the tank interior.

6.4.3.1 Inspect for loose, cracked or missing fasteners.

6.4.3.2 Inspect for defective sealant such as:

a. Previously repaired areas.

b. Cracks, scuffs, or nicks.

c. Indications of air bubbles or shrinkage.

d. Lack of adhesion by applying air pressure. Air pressure shall be a maximum 100 psi. Hold the nozzle approximately one inch from sealant.

e. Loss of luster, discoloration, chalking or loss of top coat.

f. Loss of elasticity by firmly pressing sealant with a blunt metal punch (not less than 3/16 inch diameter). The sealant is good if it gives and returns to original position. The sealant is defective if the sealant breaks or does not return to original position.

6.5 LEAK SOURCE DETECTION.

6.5.1 General.

6.5.1.1 There are several methods to locate leak sources, using either pressure or vacuum sources. The pressure methods are blow back method, pressure box method, dye injection method. Blow back and pressure box and the vacuum method incorporate the use of a non-corrosive leak detection fluid (bubble solution).

6.5.1.2 Planning is essential to locating leak sources. Locate all leak sources prior to initiating repairs.

6.5.1.3 Methods to locate leak sources are detailed in order of ease and time required, starting with the easiest and least time consuming.

6.5.2 Blow Back Method.

6.5.2.1 General. The blow back method requires access to the tank interior. This method requires at least two personnel. One will blow air on the tank exterior, the other will apply leak detection fluid to the inside of the tank and observe for leaks.

6.5.2.2 Equipment and Materials Required. Air supply, nozzle, non-corrosive leak detection compound, equipment to defuel, drain, depuddle and purge aircraft, lint free cloth, brush.

6.5.2.3 Procedures.

a. Position one repairer in the tank and the other outside the tank.

b. One repairer shall apply leak detection fluid to the tank.

c. The other repairer shall apply air pressure, from 1 to 100 psi (100 psi maximum), to the suspected leak point area. Keep nozzle approximately one inch from the surface.

d. When bubbles are detected mark where the air was applied and where the bubbles formed. Small leaks may require the use of a pressure box.

e. Recheck by applying air pressure to the points where the leak detection fluid bubbled and applying leak detection fluid to place where air was previously applied.

f. Verify marks.

6.5.3 Pressure Box Method.

6.5.3.1 General. This method works by pressurizing a large exterior surface area which in turn forces air back through the leak path in to the tank. The pressure box may be flat or contoured. This method is useful in locating seep type leaks.

6.5.3.2 Materials and Equipment Required. Control box, pig putty, pressure box, air supply, air hose, end plates, air strut, shot bags, non-corrosive leak detection compound, marking pencil, equipment to defuel, drain, depuddle and purge tanks.

6.5.3.3 Procedures.

a. Install appropriate end plates for covering structure at external leak point.

b. Mount pressure box over leak exit point. For lower surfaces support with air strut. The air strut should have at least 10 inches of free piston travel to allow for changes in wing position. For upper surfaces hold in place with shot bags.

c. Connect pressure box to control box and pressurize to four (4) psi or as specified by the aircraft technical manuals.

d. Apply air to air strut, 100 psi (or to a pressure equivalent force) or as specified in aircraft technical manuals.

e. Apply leak detection compound to suspected leak areas. Observe for bubbles.

f. Mark all leaks.

6.5.4 Dye Injection Methods.

6.5.4.1 General. This method requires a small amount of dyed fuel be injected through the leak exit point. The dye may be a red dye, which leaves a colored stain, or a fluorescent dye which is visible with the aid of an ultraviolet light (black light).

6.5.4.2 Materials and Equipment Required. Control box, two dye injecting devices (double cup or hollow bolt), vacuum cup, zinc chromate putty, pressure box, vacuum pump, air supply, vacuum hose, air hose, air strut, shot bags, dye solution, ultraviolet light, marking pencil, jet fuel, equipment to defuel, drain, depuddle and purge tanks.

6.5.4.3 Procedures.

a. Using Double Cup Assembly. The double cup assembly is used to locate leak sources by forcing dye solution through the leak exit point. Mix dye, one part fluorescent dye to ten parts fuel or one ounce red dye to 100 gallons fuel, and fill control box reservoir.

(1) Connect control box to double cup assembly. The hose from the outer segment connects to the vacuum source and the inner segment connects to the pressure dye source.

(2) Attach the double cup assembly over the leak exit point. Use zinc chromate putty, as required to ensure there are no leaks.

(3) Apply four psi air pressure, or pressure specified by the aircraft technical manuals to the dyed-fuel pressure tank. Bleed air from the dyed-fuel air pressure tank by opening the clamp on the double cup assembly until dyed-fuel is ejected, close clamp.

(4) Check for dyed fuel vapor ejection from air ejector. Any dyed fuel leaking from the cup will be sucked down the outer segment hose and blown out of the air ejector. No leakage is permitted.

b. Using the Hollow Bolt. This method forces dye between faying surfaces. The hollow bolt method should only be used when the double cup assembly method could not identify the leak source.

(1) Mix dye, one part fluorescent dye to ten parts fuel or one ounce red dye to 100 gallons fuel, and fill control box reservoir.

(2) Remove leaking fastener or fastener near leak and insert hollow bolt.

(3) Connect control box to hollow bolt with a hose to the pressure dye source of the control box.

(4) Apply four psi air pressure, or pressure specified by the aircraft technical manuals to the dyed-fuel pressure tank. Bleed air from the dyed-bolt until dyed fuel is ejected, close clamp.

(5) Enter tank and observe for indication of dye.

(6) Continue pressure application as long as required to allow dyed fuel to travel the leak path. This may require 24 or more hours.

(7) When the dye appears mark the leak sources and close flow valve.

c. Use of the Vacuum Cup. The vacuum cup may be used to confirm repairs or to identify a leak exit point by pulling air, dyed fuel or bubble solution through the tank structure and into a plastic container.

(1) Connect vacuum cup to vacuum source on control box. Use zinc chromate putty, as required to ensure there are no leaks.

(2) Attach vacuum cup to the surface over the suspected leak.

(3) Apply vacuum. Wet inside of tank with dyed fuel.

(4) Observe transparent glass for dyed fuel. Allow sufficient time for fuel to travel length of leak path.

(5) When leak appears mark leak exit point, close valve.

d. Use of Pressure Box with Dyed Fuel. This method works by pressurizing a large exterior surface area which in turn forces air back through the leak path into the tank. The pressure box may be flat or contoured. This method is useful in locating seep type leaks.

(1) Fill pressure box with dyed fuel. To reduce the amount of fuel required, a plastic sheet supporting a quantity of dyed fuel may be taped to the lower wing surface with the pressure in the box mounted on top of the sheet.

(2) Pressurize the box to force the dye back along the leak path with dye solution in the control box. Bleed air through one of the screws near the top of the pressure box.

(3) To use less dye, tape a sheet of plastic material the same size as the pressure box over the external leak point with double sided tape.

(4) Tape the flat nozzle of the dye injector bottle through the plastic material.

(5) Mount pressure box over plastic sheet, make sure box seal bears on the plastic. For lower surfaces support with air strut. The air strut should have at least 10 inches of free piston travel to allow for changes in wing position. For upper surfaces hold in place with shot bags. Use zinc chromate putty, as required to ensure there are no leaks.

(6) Remove injection bottle from nozzle and loosen tube clamp so to bleed all air from plastic sheet.

(7) Apply approximately four (4) psi air pressure-to-pressure box from the control box to force all air from inside the plastic sheet.

(8) Close tube clamp on injection bottle nozzle. Mount dyed fuel bottle to nozzle.

(9) Release pressure from pressure box, open injection bottle nozzle tube clamp, and inject dyed fuel in plastic sheet area.

(10) Close injection bottle nozzle and apply four-psi air pressure-to-pressure box using control box.

(11) Observe tank interior for dyed fuel.

(12) Mark all leaks.

6.5.5 Vacuum Dye Method.

6.5.5.1 General. The vacuum dye method is used to identify leak sources in integral tanks. A negative or vacuum pressure is applied to the tank. This method pulls dyed fuel through the leak path into the tank. The dye may be either red or fluorescent.

6.5.5.2 Materials and Equipment required. Water manometer, caps, cover plates, plugs, streamers, vacuum source, vacuum hose, dye solution, jet fuel, ultraviolet light, putty, tape, plastic bags, test door with vacuum relief, camel hair brush, syringe, marking pencil equipment to defuel, drain, depuddle and purge tanks.

6.5.5.3 Procedures.

a. Prepare tank for evacuation test in accordance with aircraft technical manuals.

b. Check manometer reservoir for proper fluid level. Only manometers with a mixture of 50 percent water and 50 percent ethylene glycol shall be used.

c. Ensure pressure connection is free of obstruction.

d. Tank test fitting shall be equipped with a vacuum relief valve.

e. All equipment taken into tank shall be inventoried.

f. All cover plates, caps, and plugs shall be attached to the test door.

g. Ensure the diameter of the water manometer hose is equal to or larger than the fuel tank line used for water manometer connection.

h. Connect manometer to tank test fitting.

i. Mix dye, one part fluorescent dye to ten parts fuel or one ounce red dye to 100 gallons fuel. Refer to T.O. 42B-1-1-10 for additional information on using dye to detect leaks.

j. Apply vacuum pressure to tank as required by aircraft technical manuals.

k. With brush or syringe apply dye to leak exit point. On lower wing surfaces it may be necessary to tape a bag full of dye to the surface to keep the area covered. On upper surfaces a dam may be constructed around the leak exit point with putty to keep the dye area wet. Keep area wet for approximately two hours, longer for small leaks.

l. Relieve pressure.

m. Enter tank and observe for leaks.

n. Mark all leak sources.

6.6 SEALING REQUIREMENTS.

6.6.1 General.

6.6.1.1 This manual will detail only those sealing procedures which do not require extraordinary personnel protective equipment, separate facilities or extended cure times.

6.6.1.2 All integral tanks are similar in design in that all, fuel containing surfaces of the wing or fuselage must be sealed fuel tight. The three main areas which require sealing are the tank boundaries, the access doors, and fasteners.

6.6.2 Access Door Sealing Methods.

6.6.2.1 Integral fuel tank access doors come in many shapes and sizes, but there are two basic types plug and direct-seal. All access doors are sealed with a static seal of which there are five main configurations, flat gasket, O-ring, molded in place, bonded in place, and formed in place.

6.6.2.2 Plug Doors. This door opens into the fuel tank and because of the design the fuel pressure tends to press the door outward which provides a tighter seal.

6.6.2.3 Direct Seal Doors. This door opens to the outside of the fuel tank and fuel pressure tends to push on the door which increases loading on the door fasteners. The door fasteners provide the clamping force to seal the door.

6.6.2.4 Flat Gasket Seal. This is the oldest method of tank access door sealing. It is simple to local manufacture and install but may wrinkle easily or require retightening to provide a fuel tight seal. They require flat mating surfaces.

6.6.2.5 O-Ring Seals. This method requires a matching groove be machined in the access door and mating surface. When properly installed they exhibit no leakage and are generally maintenance free. Disadvantages are: the O-ring can be installed in the wrong position; O-rings are hard to install around corners; and generally O-rings are not reusable.

6.6.2.6 Molded-In-Place Seals. This method has the seal molded into the access door during manufacture. They generally provide a good seal and are reusable. They cost more and when the seal fails the whole door must be replaced. Access door sealant may be used to repair minor nicks and cuts in the door seal.

6.6.2.7 Bonded-In-Place Seals. These seals are the same as molded-in-place with the exception that these seals can be removed and a new seal bonded in place of the damaged seal.

6.6.2.8 Formed-In-Place Seals. This seal is established by application of sealant, with a parting agent in the door-to-frame mating surface. The door is installed prior to cure of the sealant. Removal of the door frequently destroys the seal. The old sealant must be removed, surfaces cleaned and new sealant applied.

6.6.3 Fastener Sealing Methods.

For detailed information on structural fuel tank fastener methods refer to the aircraft technical manuals and TO 1-1A-8. The fasteners used in fuel tanks can be divided into two major types: non-self sealing and self sealing.

6.6.3.1 Non-Self Sealing Fasteners. This type of fastener cannot be installed in a hole and expected to be fuel tight. Examples are of non-self sealing fasteners are access door screws or attach bolts which slip into the holes with little or no interference. They are usually sealed by one or more of the following methods: dome nuts, sealing washers and O-rings, fastener overcoat, fillet, machine fitting, and sealant grooves.

6.6.3.2 Self Sealing Fasteners. This type of fastener seals the hole by either swelling when installed as in the case of rivets or by interference fit which is forcing of the fastener against the sides of the hole by a few thousandths of an inch.

6.6.4 Tank Boundary Sealing Methods.

6.6.4.1 Curing Type Sealing Methods. Curing type sealing methods are used on all types of aircraft. Curing type sealants normally flow during application and cure with time. The sealant remains flexible which allows it to adhere as the aircraft structure flexes. Curing type sealants may be: injected into fittings, grooves, and corners; prepacked during initial assembly; applied between faying surfaces; used to overcoat fasteners and small parts; applied as a fillet to seams, butt joints etc.; sprayed over fasteners, butt joints etc.,; or drawn through fastener voids under vacuum pressure. Tank access is normally required to apply curing type sealants. Repair of failed sealant is time consuming and adequate scheduling of repair time and facilities is necessary. Leaks generally require removal and replacement of defective sealant.

6.6.4.2 Non-Curing Type Sealing Methods. Non-curing sealants are used on many MDS of aircraft but their use is generally limited to areas where access is difficult or impossible. The sealant does not cure with time or temperature. Channels or grooves are machined into the surfaces in the tank bounder and the sealant is injected into grooves through injection ports. The injected sealant adheres to the groove and is packed between structural members to form a fuel tight seal. If the sealant develops a void, fuel will leak. To repair the leak usually at least two injection port screws are removed, one, or two, on each side of the leak path. Leaks through the faying surface are repaired from the outside by injection of new sealant into the groove. The new sealant pushes the old sealant out and fills the void. The grooves may be located between rows of fasteners, zigzagged within the fasteners, or to one side of fasteners. Injection holes are spaced at regular intervals, usually three to six inches apart and are plugged with flush screws. Proper attention must be given to assembly detail to determine which fastener is leaking and how the fastener must be sealed to prevent an inadvertent leak path.

6.6.4.3 Structural Adhesive Sealing Methods. Structural adhesive for fuel tank sealing has been used on a few aircraft. This method uses an unusually flexible structural adhesive to bond the structure together and seal the faying surfaces. Since the adhesive is flexible the fasteners carry most of the structural loading. The adhesive requires heat to cure. If a leak develops between faying surfaces they are repaired with curing type sealant fillets or overcoats.

6.7 SEALANTS.

6.7.1 General. Sealants used for permanent repairs are either curing or non-curing type. Structural adhesives are used during the manufacturing process and are not generally considered a viable repair method. Sealants used to repair aircraft require proper storage, packing, mixing, application, and inspections.

6.7.2 Storage of Sealants.

6.7.2.1 Unmixed Sealants.

a. Unmixed sealants shall be stored in accordance with the manufacturers instructions. If manufacturer's instructions are not available the following general requirements shall apply.

b. Unmixed sealants shall not be stored at temperatures above 80°F. Higher temperatures reduce storage duration.

c. Prior to expiration of the shelf life sealants shall be examined and tested for shelf life extension. Refer to AFMAN 23-110, for information on the Air Force shelf life program.

6.7.2.2 Mixed Sealants.

a. Freezing. Some multiple part sealants may be premixed and frozen for use at a later time. Manufacturer's instructions should provide guidance as to whether a product can be premixed and frozen. Due to its low temperature cure property, PR 1826 and PR 1828 cannot be premixed and frozen for later use. Mixed sealant shall be placed in a clean, airtight cartridge that has both ends capped. A container of dry ice and isobutyl or isopropyl alcohol may be used to quick freeze the sealant. A temperature of minus 100°F shall be maintained in the container. The cartridge shall be immersed nozzle end first to a depth that will cover all the cartridge except one inch. Allow five minutes for freezing, then place cartridge in a freezer and store at minus 20°F or lower. Cartridges should be labeled with the following information: manufacturer's name/CAGE code, specification, date frozen, batch number. Refer to Table 6-1 for information on storage duration.

Table 6-1. Frozen Sealant Storage (MIL-S-8802 and MIL-S-83430)

TEMPERATURE	DURATION (DAYS)
-20°F	14
-40°F	30

b. Thawing. The time consumed mixing and freezing and thawing sealants reduces total application life. Cartridges may be quick thawed in a bath of warm water (approximately 170°F). Immersion time should not exceed 15 minutes for A2, B2, B6, or C sealants. Excess water shall be wiped from the cartridge prior to issue. The cartridge shall be checked for hot spots. If hot spots are suspected the temperature of the cartridge shall be checked by inserting a thermometer into the sealant. Temperature of the thawed sealant should be between 60°F and 95°F. If the temperature of the thawed sealant exceeds 95°F the cartridge shall be discarded. Stamp or inscribe each cartridge with time of thaw.

6.7.3 Mixing of Curing Type Sealants. Sealants shall be mixed in accordance with the manufacturer's instructions or this T.O. When multiple part curing type sealant is prepared for use the accelerator shall be mixed as appropriate to obtain a thorough and complete mixture. Do not attempt to mix a partial kit without using an accurate scale to obtain proper proportioning of contents. Any sealant or accelerator found to be hard or lumpy shall be discarded. Filleting type sealants shall be machine mixed to avoid entrapment of air. Hand mixing is permitted if done in accordance with manufacturer's instructions or this T.O. Brushable type sealants may be hand mixed but machine mixing is preferred for large quantities. Hand mixing should be accomplished on a flat plate to avoid trapping air. For small hand mixed batches of brush type, Class A sealant mixing may be accomplished in the base material container if care is taken not to entrap air in the sealant.

6.7.4 Application Life of Sealants. Non-curing sealants have anunlimited application life. Curing type sealants have an application life or time during which the sealant remains suitable for use. Application time for multiple part sealants is the time that the mixed sealant remains suitable for application with a brush, injection gun or extrusion gun. Application life is based on standard conditions of 70°F and 50 percent relative humidity. Temperature and application life have an inverse relationship (refer to Table 6-2).

Sealant shall not be used, regardless of time, when it will no longer readily wets the surface to which is being applied or is beyond it's established application life.

6.7.5 Tack-Free Time. The tack-free time of a sealant is the time required for a sealant to cure to the point at which the outer surface will not stick to a plastic film (refer to Table 6-2). The tack free condition can be tested by either touching a piece of plastic or a sealing gun nozzle to the sealant. If no sealant transfers the sealant is tack-free. Fuel tanks shall not be filled until sealant is tack-free.

6.7.6 Fueling Time. Fueling time is the time required for PR 1826 and PR 1828 to cure to 30 Shore A, hardness. Fuel tanks shall not be filled until the fueling time has elapsed.

6.7.7 Sealant Cure. Curing type sealants require that applied material cure for specified times at standard conditions of 70° F and 50 percent relative humidity. Curing of sealant may be accelerated by applying heat, not to exceed 120° F and/or humidity.

6.7.7.1 Field activities. The following is for a pre-use test of the sealant. For instructions on shelf life extension refer to APPENDIX A. For mixing of small amounts of curing type sealants use the following instructions:

a. Spread a thin layer of mixed sealant on a strip of aluminum and visually examine the sealant for small particles of accelerator.

b. If particles remain after five minutes of mixing dispose of corresponding batch of mixed sealant. After mixing, sealants shall have a minimum application time as specified by its dash number. Sealants that will not wet the surface or spread smooth shall be discarded.

Table 6-2. Tack Free Time (In Hours)

A-1/2 AND B-1/2 MATERIALS (MIL-S-8802 AND MIL-S-83430)

TEMPERATURE (°F)	35% RH	50% RH	65% RH	90% RH
50	40	35	30	20
55	34	24	19	15
60	30	20	18	12
65	25	18	12	9
70	22	13	9	7
75	19	12	8	4
80	18	9	7	3
85	13	8	5	2
90	12	7	4	2
95	10	5	3	1
100	9	4	2	1
105	8	3	2	
110	7	2	1	

A-2 AND B-2 MATERIALS (MIL-S-8802 AND MIL-S-83430)

TEMPERATURE (°F)	35% RH	50% RH	65% RH	90% RH
50	160	140	120	80
55	135	95	75	60
60	120	80	70	48
65	100	70	45	36
70	85	50	35	28
75	75	45	30	16
80	70	35	25	12
85	50	30	20	10
90	45	25	15	8
95	40	20	10	6
100	35	15	10	4
105	30	10	5	2
110	25	10	5	1

Table 6-2. Tack Free Time (In Hours) - Continued

FUELING TIME (IN HOURS), B-1/4, B-1/2 AND B-2 MATERIALS (PR 1826)

TEMPERATURE (°F)	B-1/4	B-1/2	B-2
20	8	16	64
40	4	8	32
77	1	2	8

6.8 PERMANENT REPAIRS.

6.8.1 General. Permanent repairs are those repairs which require no further maintenance to the aircraft, excluding temporary repairs. The fuel leak classifications of Chapter 4 and applicable aircraft technical manuals shall be followed when determining the degree of allowable leakage and corrective action. Those leaks which require permanent repair shall be repaired using the information contained in this manual and the aircraft technical manuals.

6.8.2 Non-Curing Type Sealant Repairs.

6.8.2.1 General. If needed locally constructed fixtures or stands may be used to hold the injection gun during overhead operations. Some sealants become stiff when cold, if necessary apply heat to the groove area to aid in flushing out the old sealant. Defuel the aircraft as necessary to facilitate sealant injection. Usually one damaged injection screw will not prevent adequate sealant injection, however, if two or more consecutive injection screws are damaged they shall replaced.

6.8.2.2 Materials and Equipment Required: Injection gun, nozzles, air source, sealant, tools to remove injection screws, equipment to defuel aircraft.

6.8.2.3 Procedures.

a. With leak path analysis, review sealing system structure and corrosion repair completed use the following procedures:

b. Defuel aircraft below the leak point if necessary.

c. Remove injection screws as required.

d. Use injection gun, nozzle, sealant and air pressure required by aircraft technical order.

e. Load injection gun. Sealant may be either a prepacked cartridge or hand-packed in the gun. If gun is hand-packed ensure all air pockets are eliminated.

f. Set air pressure and connect injection gun to air source.

g. Discharge a small amount of sealant to eliminate trapped air.

h. Insert nozzle in injection port. Inject sealant until a string of sealant approximately twice as long as the distance between the holes is extruded. This assures the old sealant is removed, all voids are filled and new sealant can adhere to the walls of the groove.

i. For repair of long leak paths or hard to identify leak exit points remove additional injection screws as necessary. Start at one end of the leak path and remove two injection screws repeat injection process. Working toward the other end of the leak path remove one additional injection screw and replace injection screw previous port. Inject sealant, continue until leak is repaired.

j. Replace injection screws.

6.8.3 Curing Type Sealant Repairs.

6.8.3.1 Seams and Surfaces.

a. Prepacked Seals. Prepacked seals which leak require disassembly to repair or if disassemble is not practical the area can be repaired with a sealant overcoat or fillet.

b. Injection Seals. Injection seals may or may not require disassembly to repair.

c. Faying Surface Seals. Faying surface seals normally require disassembly to repair.

d. Fillet Seals. Fillet seals are normally repaired by removal of the old sealant and application of a new sealant fillet.

e. Brush Coat or Overcoat Seals. These type of seals are normally repaired by removal of the old sealant and application of new sealant.

6.8.3.2 Materials and Equipment Required: Solvent, lent free cheesecloth, scraper, spatula, hooked wire, cutting tool, adhesion promoter, sealant, stiff bristle brush, lint free wiping cloths, abrading material, gauze pads, acid brush, safety container, cotton gloves, chemical resistant gloves, barrier material, equipment to defuel, drain, and purge aircraft.

6.8.3.3 Procedures.

a. Surface Preparation.

(1) Repair Damaged Structure or Corrosion. All structural damage shall be accomplished in accordance with the aircraft technical manuals. Corrosion removal and treatment shall be in accordance with T.O. 1-1-691 and the applicable aircraft technical manuals. Application or repair of coating MIL-C-27725 shall be in accordance with T.O. 1-1-8.

(2) Removal of Damaged Seals. Cover bottom of tank, if necessary, with barrier material or wiping cloths to protect tank coating from debris, tools, and other foreign materials. Using spatula or scraper remove defective sealant. Sealant from short prepacked or injection seals may be removed with a hooked wire and a small cutting tool. The entire seal shall be clear to permit complete filling with new sealant. Sealant from faying surfaces and some prepacked surfaces or long injection seals cannot be removed without structural disassembly. Consult prime ALC (SPM) and aircraft technical manuals for disassembly instructions. Defective fillet seals shall be removed and have the ends cut or tapered to approximately a 45 degree angle. Abrade at least inch on each end of the fillet to prepare surface for new fillet seal. Place removed sealant in a bag or container. For an injection seal, clear entire channel or groove of old sealant to prevent trapped air from creating an new leak path.

(3) Cleaning of Surfaces to be Sealed. Remove all debris and foreign materials from the tank. Starting from the top clean all surfaces with four-part cleaner or MEK and cheesecloth or gauze pads. The solvent will cause oil, grease, fuel dirt, etc., to float to the surface and make it easy to remove by wiping. Do not allow the solvent to dry. A stiff bristle brush may be used to clean heavy deposits, fasteners, bolts etc. To avoid contaminating the solvent always pour solvent on to the cloth. Change cheesecloth as often as necessary. Wipe area dry with cheesecloth and repeat cleaning process at least one additional time to ensure area is clean. Once the area has been cleaned do not surface with bare hands, as oil or dirt will contaminate the surface and the sealant will not adhere.

(4) Covering Exposed Cadmium Plated Parts. All cadmium plated parts which are to be sealed with curing type sealants specification MIL-S-8802, MIL-S-83430, or MIL-S-81733, should be isolated with either EC1945 or MIL-C-27725. This topcoat shall be fully dried prior to application of adhesion promoter and sealing material.

(5) Application of Adhesion Promoter. When applying adhesion promoter follow the requirements in this tech-data (T.O. 1-1-3) or manufacture instructions if provided. Apply a light coat of adhesion promoter to the surfaces that require faying surface seals, fillet seals or prepacked seals. The adhesion promoter may be applied by fine bristle brush or with cheesecloth. Excess adhesion promoter shall be removed by blotting with cheesecloth. The promoter shall be allowed to dry for 30 minutes before sealant is applied. If more than 24 hours have elapsed or the surface has become contaminated since the application of the adhesion promoter the surface shall be recleaned and new adhesion promoter applied. When applying a pre-coat sealant followed by a fillet seal the adhesion promoter can be applied to the tack-free surface of the pre-coat sealant. Adhesion promoter should be discarded when it becomes cloudy.

b. Sealant Selection. Select the proper sealant in accordance with the aircraft technical manuals. Multiple part curing type sealants shall be mixed in accordance with paragraph 6.7.3 and the application time noted. Sealant shall not be used, regardless of time, when it will no longer readily wets the surface to which is being applied or is beyond it's established application life.

c. Sealant Application. Do not apply sealant to surface if temperature is less than 60°F. A bimetallic thermometer should be used to check surface temperature. A combination of seals may be required at a single leak location.

(1) Application of Brush Coat Seal. The brush coat may be used for fillets and is applied 0.10 inch wider than the fillet on either side of the seam. Using a brush, apply a seal of brush able curing type sealant on top of the adhesion promoter. The brush coat seal is worked into an around crevices, holes, seams, fasteners, and on the surfaces to be sealed. Allow the surface to become tack-free before application of final seal. Brush coats shall not be used over any primary seal.

(2) Application of Fillet Seal or Isolation Seal.

(a) Apply adhesion promoter if required.

(b) Insert mixed fillet type sealant into filleting gun.

(c) Select nozzle for size of fillet to be applied. Small fillet require a nozzle with a small orifice, likewise large fillets require a nozzle with a large orifice. If necessary set up a locally fabricated device, to simulate the components to be filleted, to help determine orifice size.

(d) Apply a bead of sealant, for large repairs apply the sealant in approximately three foot lengths.

(e) Work the bead of sealant, with a spatula, to fill all voids in the seam and to remove all trapped air. Removing all trapped air is extremely important to obtaining a leak free service life of the repair.

(f) For small fillets, a single bead is all that is required. Shape the fillet to conform to the dimensions shown in Figure 6-30 or in accordance with the aircraft technical manual. After the sealant is tack-free examine the fillet for air bubbles. Repeat repair for any air pockets found.

(g) For large fillets, a double bead should be applied. Apply a small bead and work into all voids to remove all trapped air. Allow to cure to tack-free and examine for air bubbles. Bubble cavities shall be enlarged to permit easy filling during application of final full-bodied fillet.

(h) Apply final full bodied fillet and shape to conform to the dimensions shown in Figure 6-30 or as required in the aircraft technical manual. After sealant is tack-free examine for air bubbles. Repeat repair for any air pockets found.

(3) Application of Injection Seals.

(a) Insert the mixed filleting type curing sealant into the injection gun.

(b) For an open void, inject sealant until it extrudes from the opposite end and then slowly remove injection gun.

(c) For closed voids, a long injection tip is required to reach the bottom of the void. Inject sealant and slowly remove injection gun while continuing to inject sealant. Completely fill void with sealant. Use care not to trap air in the sealant.

(4) Application of Faying Surface Seal.

(a) Insert mixed filleting type curing sealant in filleting gun.

(b) Apply sealant to faying surfaces. Filleting tip should be large enough to apply a bead of sealant that can be spread over the whole surface and allow some sealant to be squeezed out when the parts are assembled.

(c) Spread sealant evenly over entire surface.

(d) Assemble part and clamp with setup bolts, wing type Cleco fasteners, or other temporary fasteners.

(e) Install permanent fasteners, retighten fasteners twice within 30 minutes or before the sealant reaches the end of its application time.

(f) Remove excess extruded sealant.

6.8.3.4 Repair of Chalking Sealant.

a. As sealant ages it may develop areas of chalking. These will appear as light colored powdery areas on the sealant.

b. Materials and Equipment Required: Four-part cleaner, MEK, lint-free cheesecloth, stiff bristle brush, safety container, chemical resistant gloves, air operated vacuum cleaner, materials and equipment to apply top-coat, equipment to defuel, drain, and purge aircraft.

c. Procedures.

(1) Scrub chalky area vigorously with a dry stiff bristle brush. Hold vacuum cleaner hose near work are to pick up chalk dust.

(2) Clean affected area with solvent and cheesecloth. Dry with clean cheesecloth.

(3) Apply sealant top coat.

6.8.4 Fasteners.

6.8.4.1 General. Fasteners used in integral tanks are sealed in a variety of ways. A combination of sealing methods may be used on any single or group of fasteners. Always ensure fasteners are torqued to the proper value before applying sealant. ALC maintenance activities should consult the aircraft documents and remove all temporary repairs and seal the aircraft in accordance with the following or specific weapon system manuals.

6.8.4.2 Materials and Equipment Required.

6.8.4.3 Fastener Repair Procedures.

a. Surface Preparation.

(1) Repair Damaged Structure or Corrosion. All structural damage shall be accomplished in accordance with the aircraft technical manuals. Corrosion removal and treatment shall be in accordance with T.O. 1-1-691 and the applicable aircraft technical manuals. Application or repair of coating MIL-C-27725 shall be in accordance with T.O. 1-1-8.

(2) Removal of Damaged Sealant. Cover bottom of tank, if necessary, with barrier material or wiping cloths to protect tank coating from debris, tools, and other foreign materials. Using spatula or scraper remove defective sealant. The entire seal shall be clear to permit complete filling with new sealant. Consult prime ALC (SPM) and aircraft technical manuals for disassembly instructions. Place removed sealant in a bag or container. For an injection seal, clear entire channel or groove of old sealant to prevent trapped air from creating a new leak path.

(3) Cleaning of Surfaces to be Sealed. Remove all debris and foreign materials from the tank. Starting from the top clean all surfaces with four-part cleaner or MEK and cheesecloth or gauze pads. The solvent will cause oil, grease, fuel dirt, etc., to float to the surface and make it easy to remove by wiping. Do not allow the solvent to dry. A stiff bristle brush may be used to clean heavy deposits, fasteners, bolts etc. To avoid contaminating the solvent always pour solvent on to the cloth. Change cheesecloth as often as necessary. Wipe area dry with cheesecloth and repeat cleaning process at least one additional time to ensure area is clean. Once the area has been cleaned do not surface with bare hands, as oil or dirt will contaminate the surface and the sealant will not adhere.

(4) Covering Exposed Cadmium Plated Parts. All cadmium plated parts which are to be sealed with curing type sealants specification MIL-S-8802, MIL-S-83430, or MIL-S-81733, should be isolated with either EC1945 or MIL-C-27725. This topcoat shall be fully dried prior to application of adhesion promoter and sealing material.

(5) Application of Adhesion Promoter. When applying adhesion promoter follow the requirements in this tech-data (T.O. 1-1-3) or manufacture instructions if provided. Apply a light coat of adhesion promoter the surfaces that require fillet seals or brush-coat seals. The adhesion promoter may be applied by fine bristle brush or with cheesecloth. Excess adhesion promoter shall be removed by blotting with cheesecloth. The promoter shall be allowed to dry for 30 minutes before sealant is applied. If more than 24 hours have elapsed or the surface has become contaminated since the application of the adhesion promoter the surface shall be recleaned and new adhesion promoter applied. When applying a pre-coat sealant followed by a fillet seal the adhesion promoter can be applied to the tack-free surface of the pre-coat sealant. Adhesion promoter should be discarded when it becomes cloudy.

b. Sealant Selection. Select the proper sealant in accordance with the aircraft technical manuals. Multiple part curing type sealants shall be mixed in accordance with paragraph 6.7.3 and the application time noted. Sealant shall not be used, regardless of time, when it will no longer readily wets the surface to which is being applied or is beyond it's established application life.

c. Sealant Application. Do not apply sealant to surface if temperature is less than 60°F. A bimetallic thermometer should be used to check surface temperature. A combination of seals may be required at a single leak location.

d. Self-Sealing Fasteners. Repair by brush coat or replace fastener.

e. Fasteners with Sealing Washers or O-Rings. Torque fastener to specifications if this does not stop the leak remove the fastener and inspect the O-ring for nicks, cuts, abrasions, deterioration, or deformation. If any of these conditions are found replace the O-ring and reinstall the fastener. If the O-ring is not damaged or if replacing the O-ring does not stop the leak replace the fastener or apply a click patch.

f. Fasteners Located in Sealant Grooves. Repair by injection of non-curing sealant or apply click patch.

g. Fasteners Sealed by Brush-Coat and Fillet. Repair using the following procedures.

(1) Materials and Equipment Required. Scraper, solvent, lint-free cheese cloth, acid brush, adhesion promoter, sealant, filleting gun, spatula

(2) Procedure.

(a) Application of Brush Coat Seal. The brush coat may be used for fillets. Shape the fillet to conform to the dimensions shown in Figure 6-30 or in accordance with the aircraft technical manual. Using a brush, apply a seal of brush able curing type sealant on top of the adhesion promoter. The brush coat seal is worked into an around crevices, holes, seams, fasteners, and on the surfaces to be sealed. Allow the surface to become tack-free before application of final seal. Brush coats shall not be used over any primary seal. After the sealant is tack-free examine the sealant for air bubbles. Repeat repair for any air pockets found.

(b) Application of Fillet Seal.

1 Insert mixed fillet type sealant into filleting gun.

2 Select nozzle for size of fillet to be applied. Small fillets require a nozzle with a small orifice, likewise large fillets require a nozzle with a large orifice. If necessary set up a locally fabricated device, to simulate the components to be filleted, to help determine orifice size.

3 Apply a bead of sealant.

4 Work the bead of sealant, with a spatula, to fill all voids in the sealant and to remove all trapped air. Removing all trapped air is extremely important to obtaining a leak free service life of the repair.

5 For small fillets, a single bead is all that is required. Shape the fillet to conform to the dimensions shown in Figure 6-30 or in accordance with the aircraft technical manual. After the sealant is tack-free examine the fillet for air bubbles. Repeat repair for any air pockets found.

h. Fasteners Sealed with Dome Nuts. Repair by brush coat or replace dome nut.

i. Wet Installed Fasteners.

(1) General. Repair by using the following procedures. The aircraft may not need to be defueled for this procedure.

(2) Materials and Equipment Required. Scraper, solvent, lint-free cheese cloth, acid brush, adhesion promoter, sealant, filleting gun, and spatula.

(3) Procedures.

(a) Clean hole and surrounding area with solvent and cheesecloth. A non-tipped swab may be used for small holes.

(b) Clean fastener.

(c) Apply adhesion promoter to fastener and walls of hole.

(d) Apply a small bead of curing type filleting sealant around shoulder of fastener.

(e) Install fastener and tighten to proper torque. Final torque shall be applied before sealant reaches the end of its application life.

6.8.5 Access Doors, Component Doors.

6.8.5.1 General. Access and component doors used in integral tanks are sealed in a variety of ways. A combination of sealing methods may be used to seal a door.

6.8.5.2 Materials and Equipment Required. Sealant, parting agent, desealant, container, lint-free cheesecloth, scraper, spatula, filleting gun, solvent, clear water, equipment to defuel, drain and purge aircraft.

6.8.5.3 Surface Preparation.

a. Repair Damaged Structure or Corrosion. All structural damage shall be accomplished in accordance with the aircraft technical manuals. Corrosion removal and treatment shall be in accordance with T.O. 1-1-691 and the applicable aircraft technical manuals. Application or repair of coating MIL-C-27725 shall be in accordance with T.O. 1-1-8.

b. Removal of Damaged Sealant. Cover bottom of tank, if necessary, with barrier material or wiping cloths to protect tank coating from debris, tools, and other foreign materials. Using desealant, Specification MIL-D-9063, or a spatula or scraper remove defective sealant. The entire seal shall be clear to permit complete filling with new sealant. Place removed sealant in a bag or container.

c. Use of Desealant, Specification MIL-D-9063.

d. For small items or items which have no moving parts, glass, plastic or rubber, soak the items in a container of desealant. If the item cannot be soaked apply the desealant with a brush. After the desealant has been in contact with the sealant for ten minutes rinse non-moving items in clear water. Items with moving parts shall be wiped with a damp cloth. Clean all parts with solvent in accordance with paragraph 6.8.5.3.e.

e. Cleaning of Surfaces to be Sealed. Remove all debris and foreign materials from the door. Starting from the top clean all surfaces with four-part cleaner or MEK and cheesecloth or gauze pads. The solvent will cause oil, grease, fuel dirt, etc., to float to the surface and make it easy to remove by wiping. Do not allow the solvent to dry. A stiff bristle brush may be used to clean heavy deposits, fasteners, bolts etc. To avoid contaminating the solvent always pour solvent on to the cloth. Change cheesecloth as often as necessary. Wipe area dry with cheesecloth and repeat cleaning process at least one additional time to ensure area is clean. Once the area has been cleaned do not surface with bare hands, as oil or dirt will contaminate the surface and the sealant will not adhere.

f. Covering Exposed Cadmium Plated Parts. All cadmium platted parts which are to be sealed with curing type sealants specification MIL-S-8802, MIL-S-83430, or MIL-S-81733, should be isolated with either EC1945 or MIL-C-27725. This topcoat shall be fully dried prior to application of adhesion promoter and sealing material.

6.8.5.4 Sealant Selection. Select the proper sealant in accordance with the aircraft technical manuals. A low adhesion curing type sealant is preferred, however, a standard curing type sealant may be used. If a standard curing type sealant is used a parting agent shall be applied to one of the mating surfaces. Multiple part curing type sealants shall be mixed in accordance with paragraph 6.7.3 and the application time noted. Sealant shall not be used, regardless of time, when it will no longer readily wets the surface to which is being applied or is beyond it's established application life.

6.8.6 Door Repair Procedures.

a. Seal Replacement. Use the aircraft technical manuals and the following procedures to replace compression type seals such as flat gaskets, O-rings, and bonded in place seals.

   (1) Remove seal from door.

   (2) Clean sealing surface of door.

   (3) Replace gasket using proper sealant or adhesive as required.

   (4) Install door and torque fasteners.

b. Door Fastener Repair. Leaking door fasteners shall be repaired in accordance with the aircraft technical manual, paragraph 6.8.4, or the following (the tank may not need to be defueled for this procedure):

   (1) Torque fastener to value required by aircraft technical manual.

   (2) If leak continues remove fastener.

   (3) Clean fastener and hole.

   (4) Apply a bead of filleting type curing sealant to fastener shank.

   (5) Install fastener and tighten to proper torque. Final torque shall be applied before sealant reaches the end of its application life.

6.8.7 Component Replacement Procedures.

6.8.7.1 General. Use the aircraft technical manuals and the following to repair or replace accessory components such as booster pumps, cover plates, and etc., sealed with curing type sealant.

6.8.7.2 Equipment and Materials Required. Scraper, parting agent.

6.8.7.3 Procedures.

a. Remove old sealant.

b. Clean components.

c. Apply parting agent to one surface.

d. Apply sealant to other surface.

e. Install and torque attaching hardware.

f. Fillet seal the edges as required.

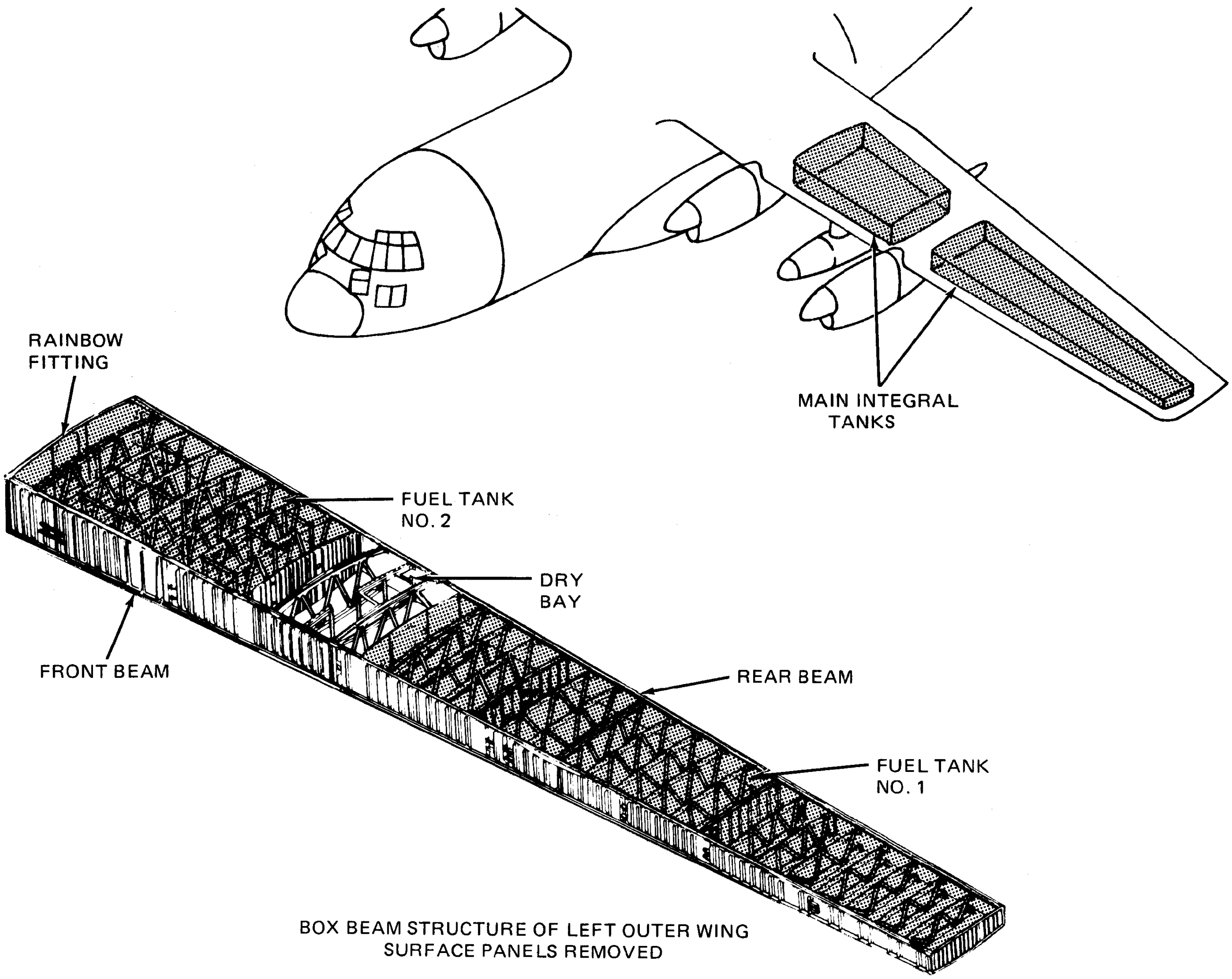


Figure 6-1. Typical Integral Fuel Tanks

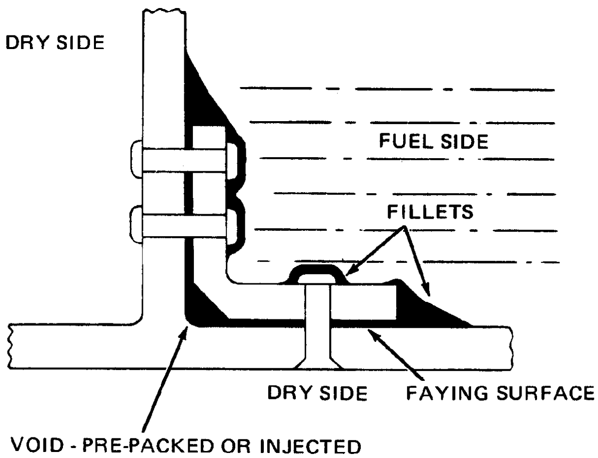
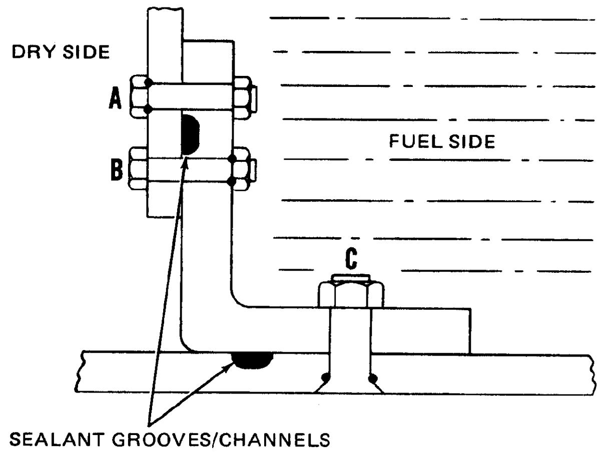


Figure 6-2. Curing Sealant Design



NOTE

FASTENER A MAY BE SEALED ON EITHER END. FASTENER B MUST BE SEALED ON NUT END AND FASTENER C MUST BE SEALED IN THE COUNTERSINK.

Figure 6-3. Non-Curing Sealant Design

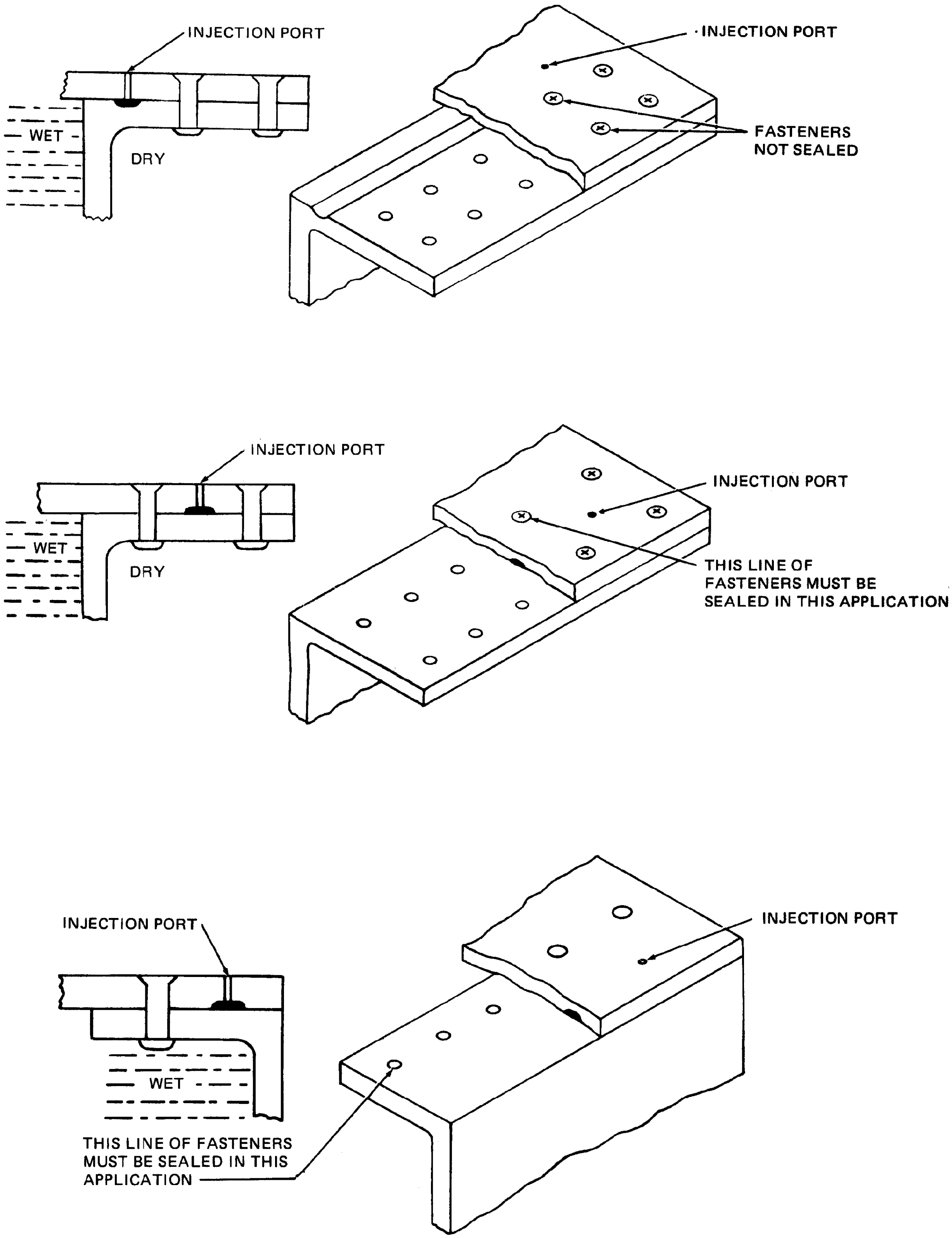


Figure 6-4. Typical Locations of Grooves/Channels (Sheet 1 of 2)

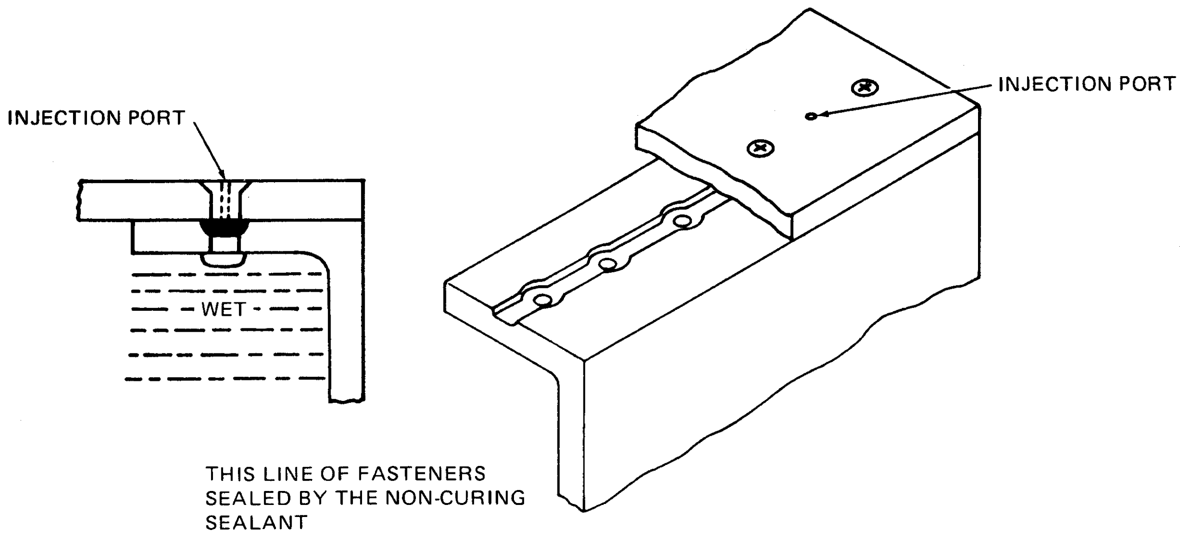


Figure 6-4. Typical Locations of Grooves/Channels (Sheet 2)

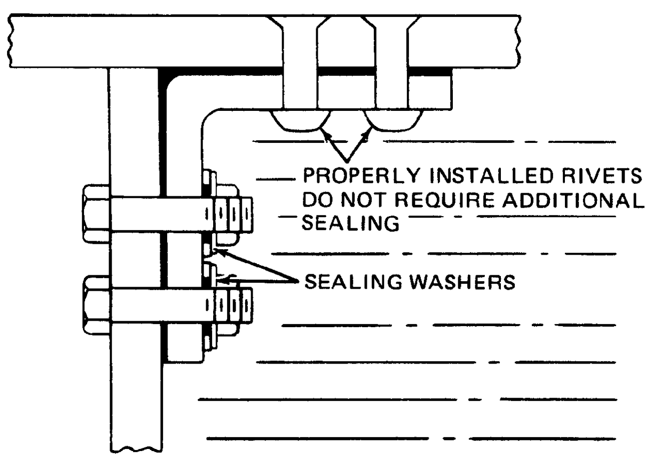


Figure 6-5. Structural Adhesive Sealing

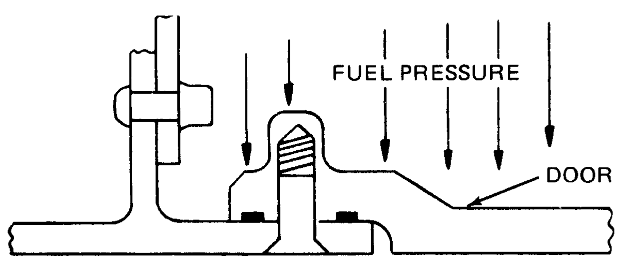


Figure 6-6. Plug Door

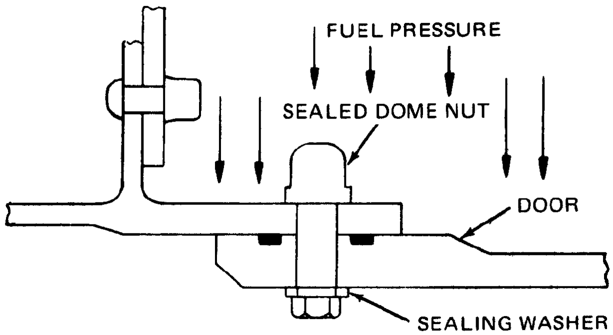


Figure 6-7. Direct Seal Door

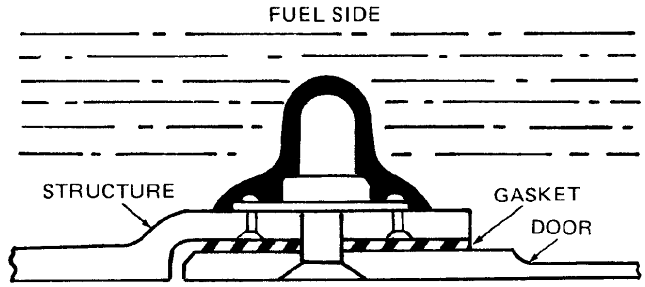


Figure 6-8. Flat Gasket Seal

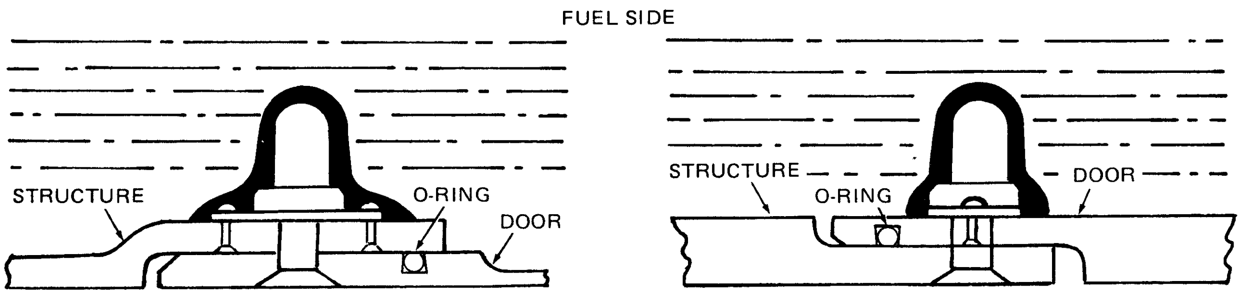


Figure 6-9. O-Ring Seal

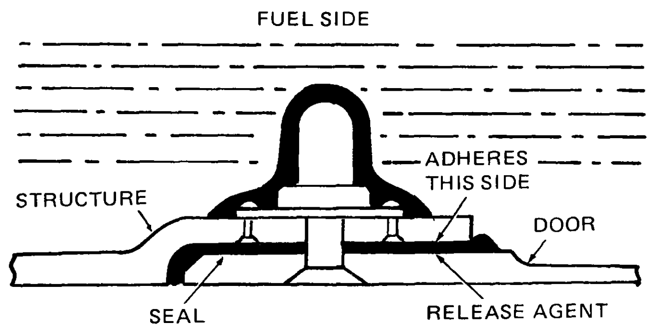


Figure 6-10. Formed-In-Place Seal

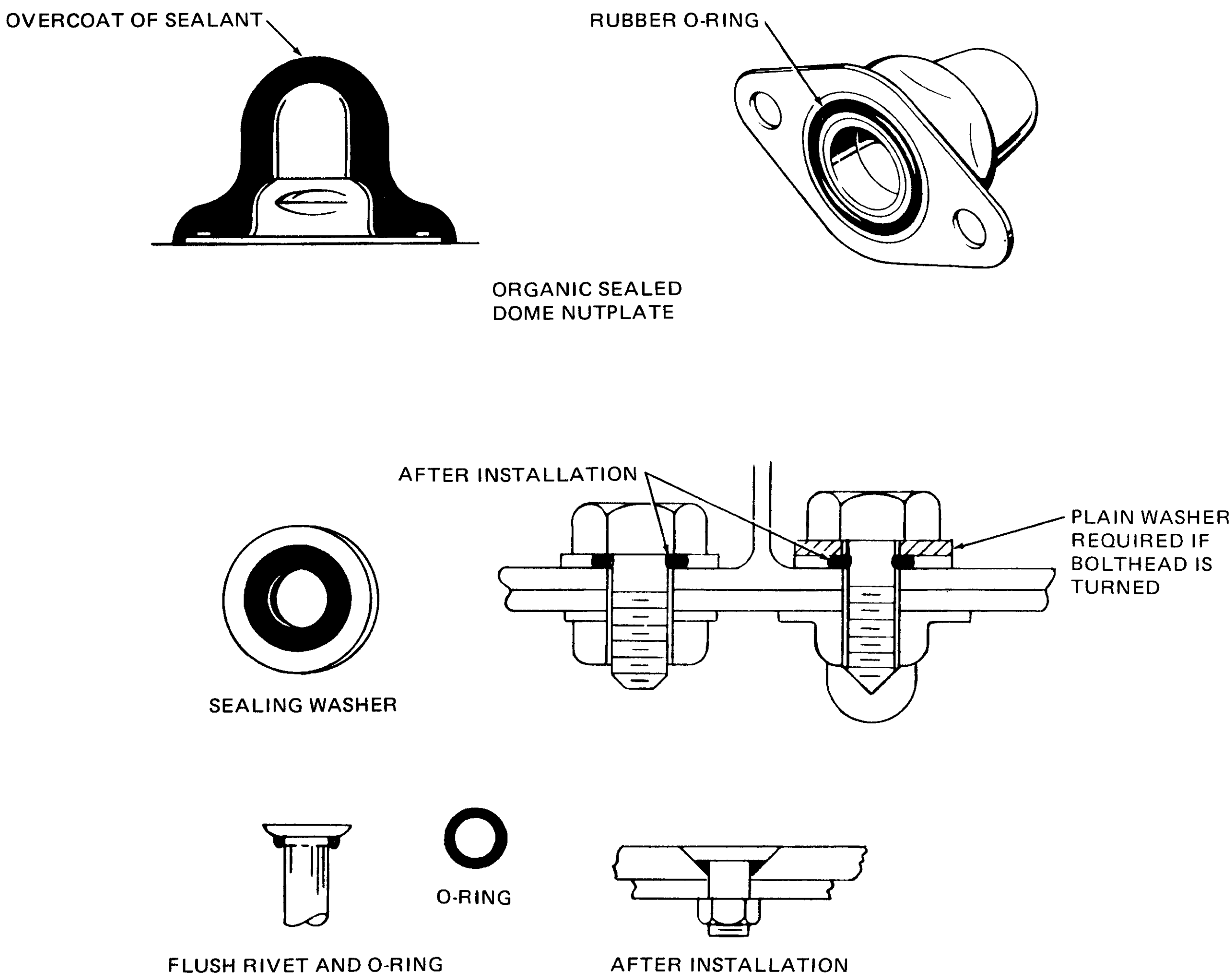


Figure 6-11. Typical Fastener Seals

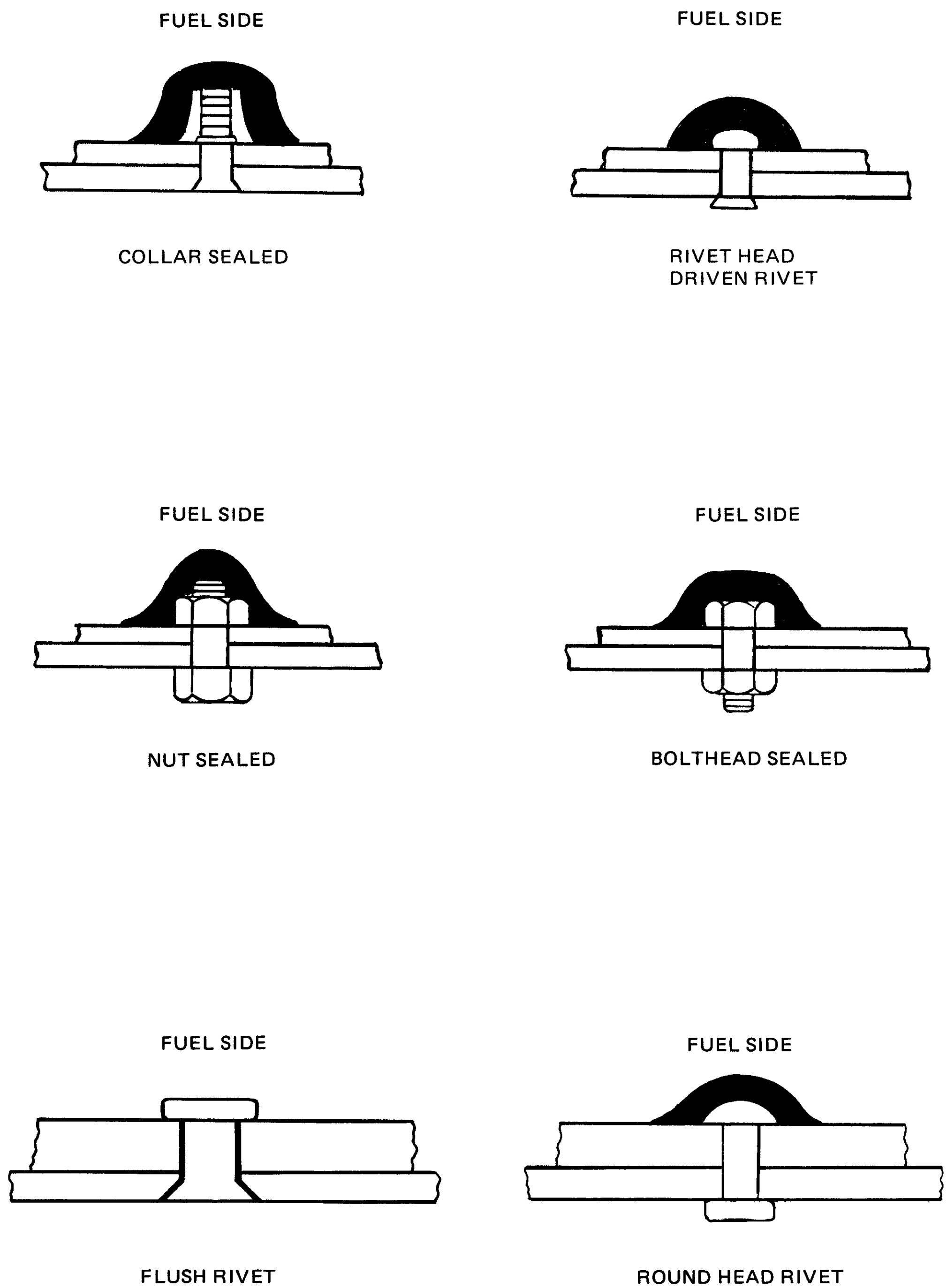


Figure 6-12. Typical Fasteners, Overcoat and Fillet

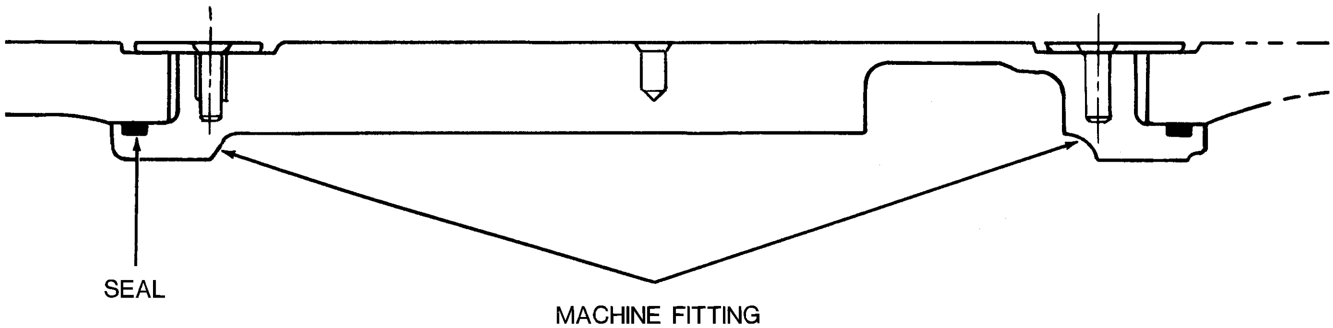


Figure 6-13. Machine Fitted Plug-Type Access Door for Attaching Screws

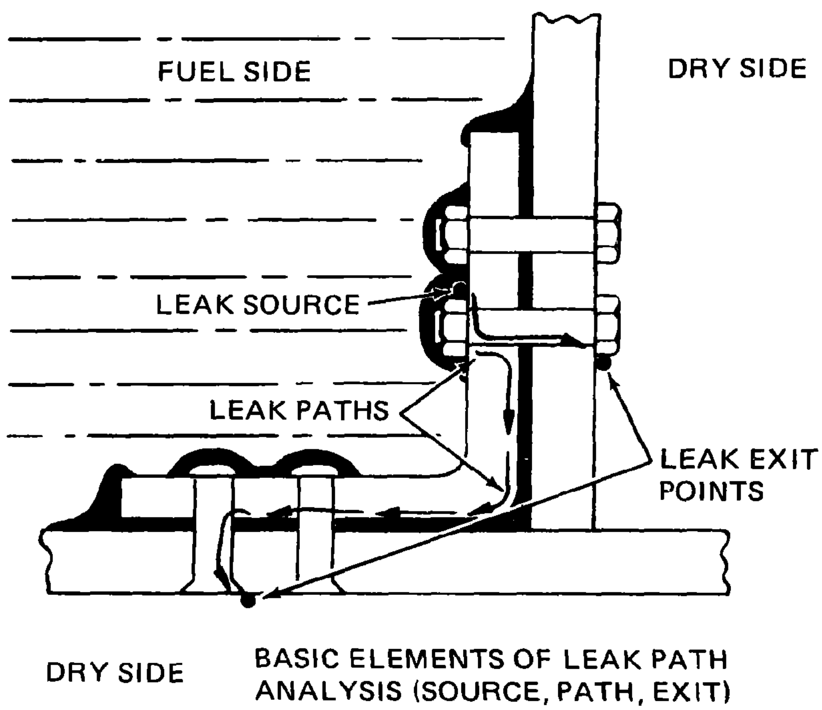


Figure 6-14. Leak Path Analysis

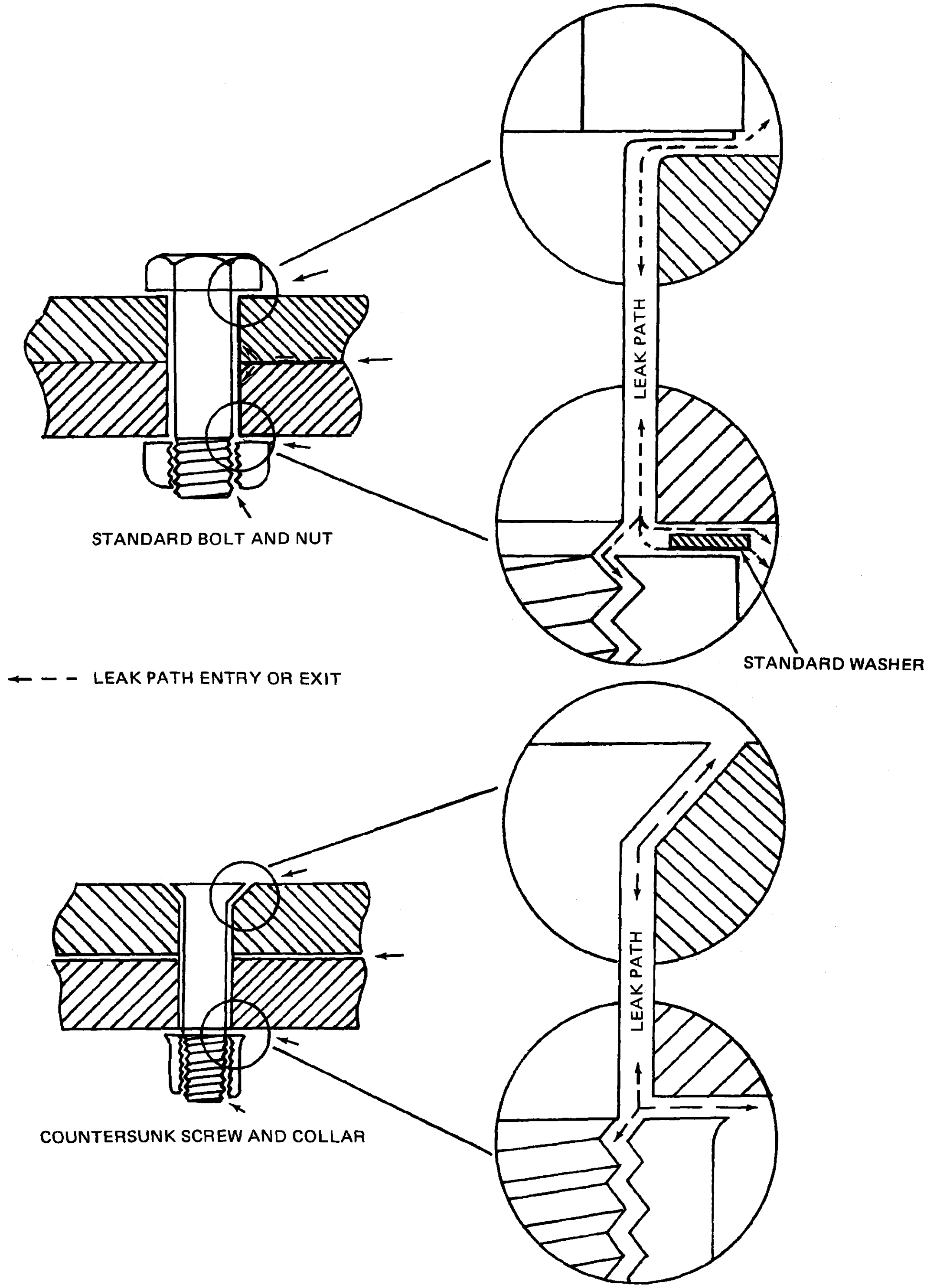


Figure 6-15. Fasteners Leaks

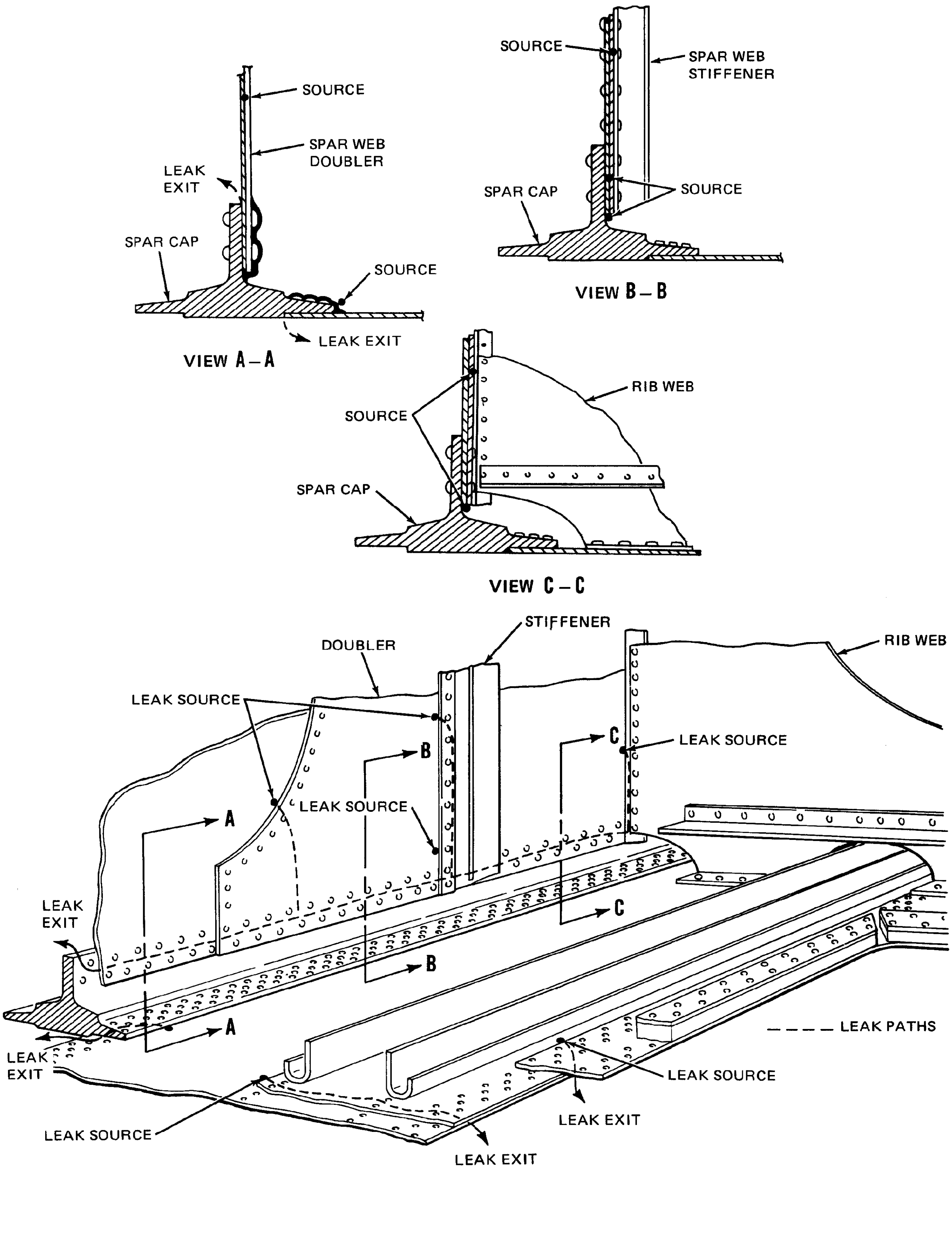


Figure 6-16. Examples of Long Leak Paths

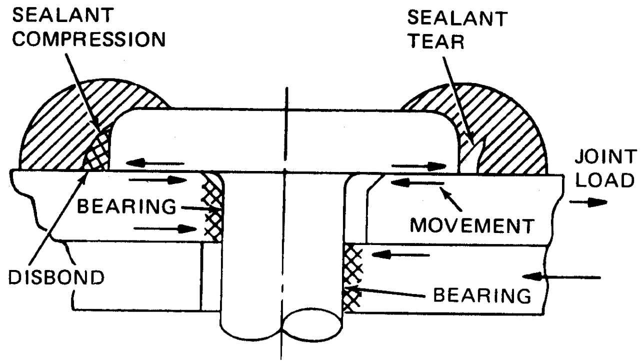


Figure 6-17. Fastener Movement on Oversize Hole

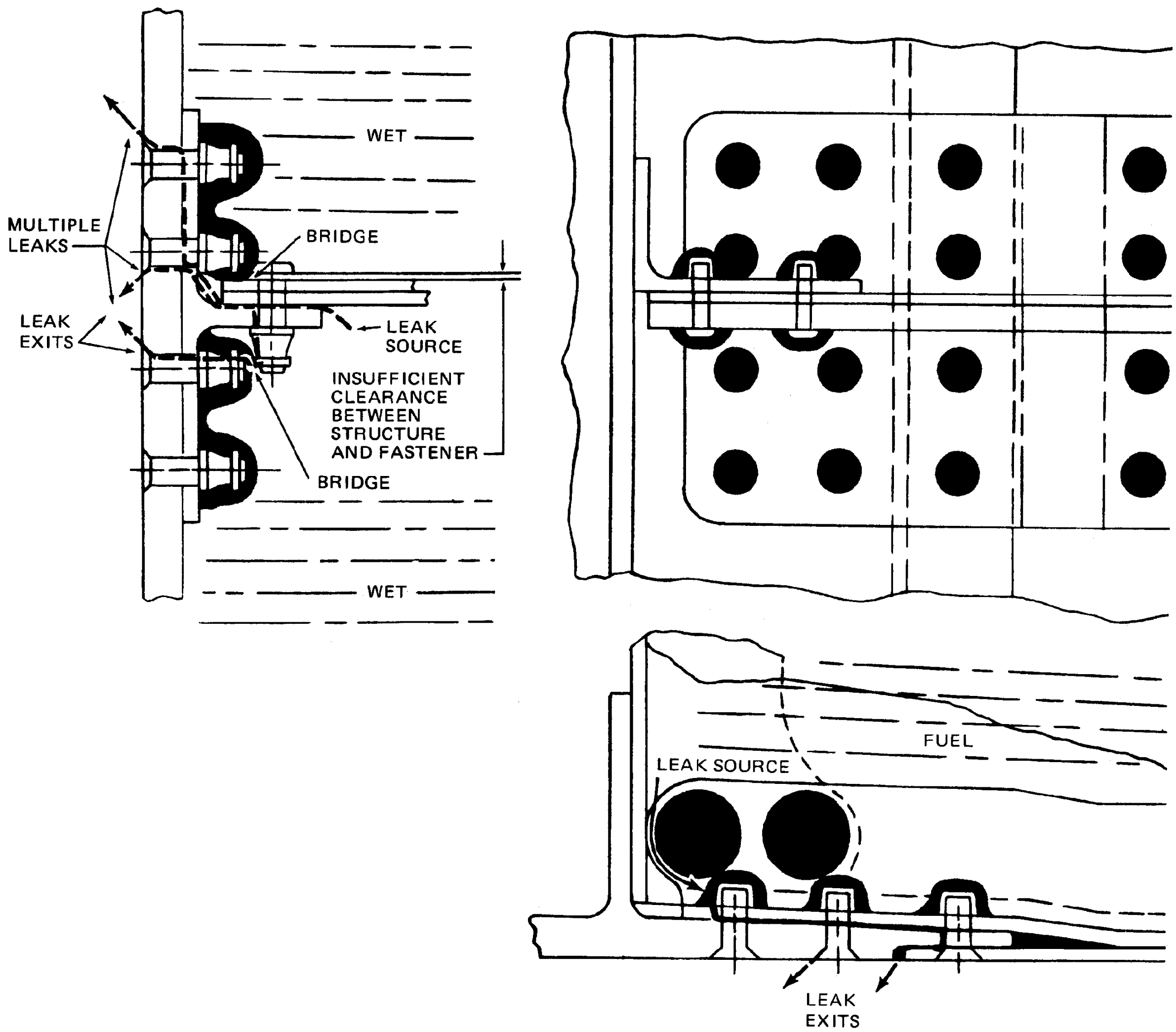
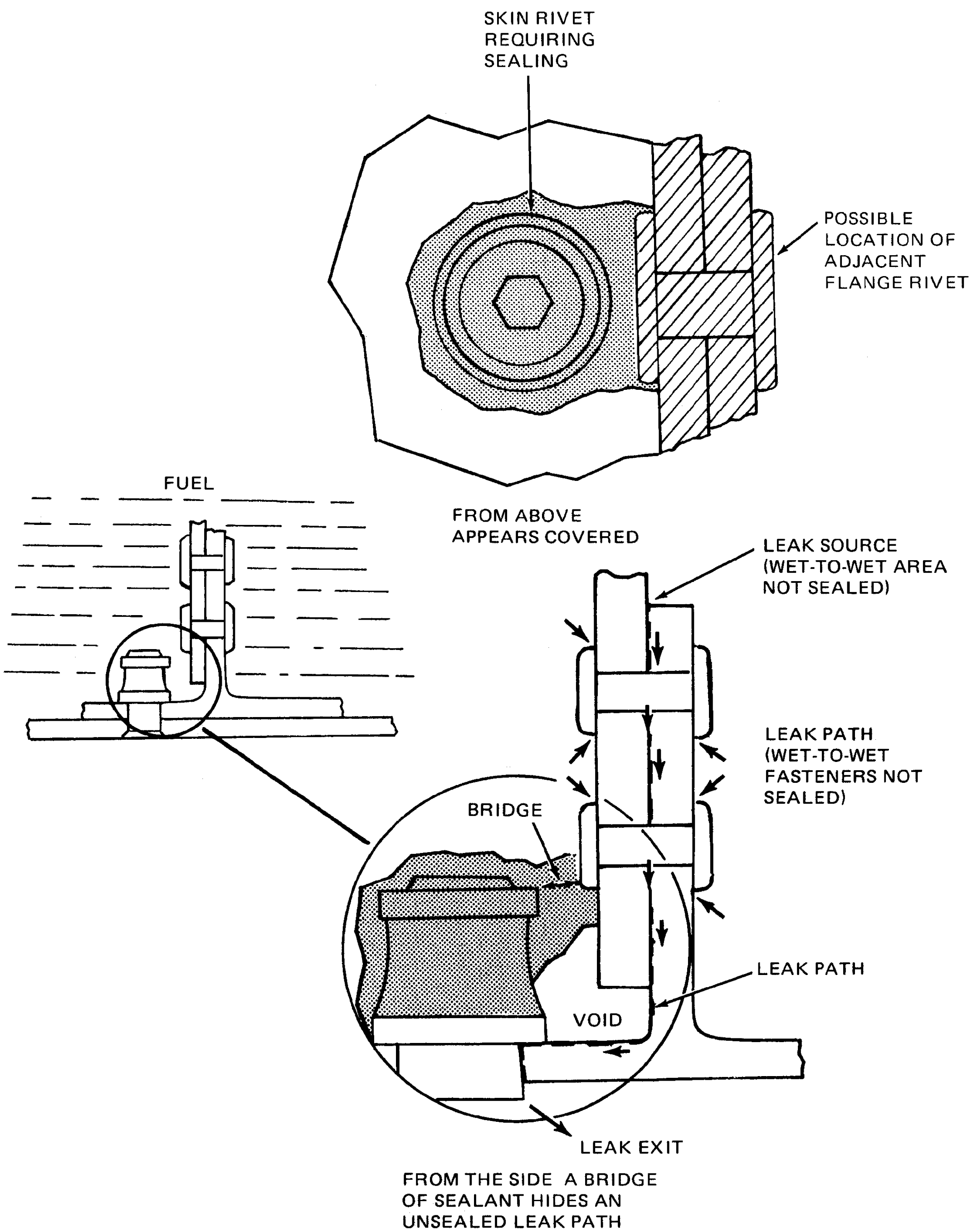


Figure 6-18. Multiple Leak Paths From a Single Leak Source



NOTE

SOME LEAK PATHS CAN BE CREATED THAT ARE ALMOST IMPOSSIBLE TO FIND AND SEAL SUCH AS THE CREATION OF BRIDGES BETWEEN CLOSELY POSITIONED FASTENERS.

Figure 6-19. Sealant Bridging

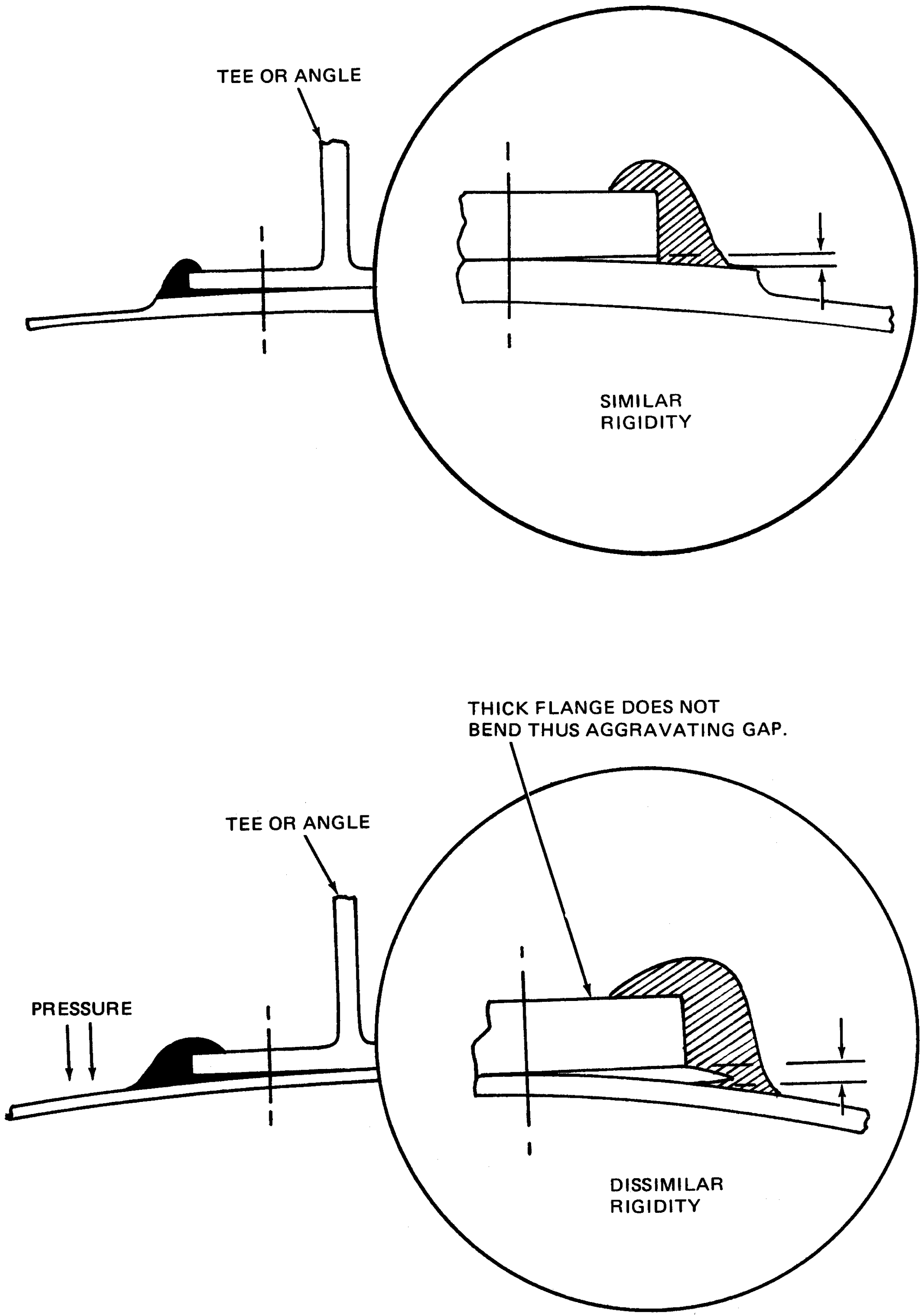


Figure 6-20. Fillet Seal Deflection

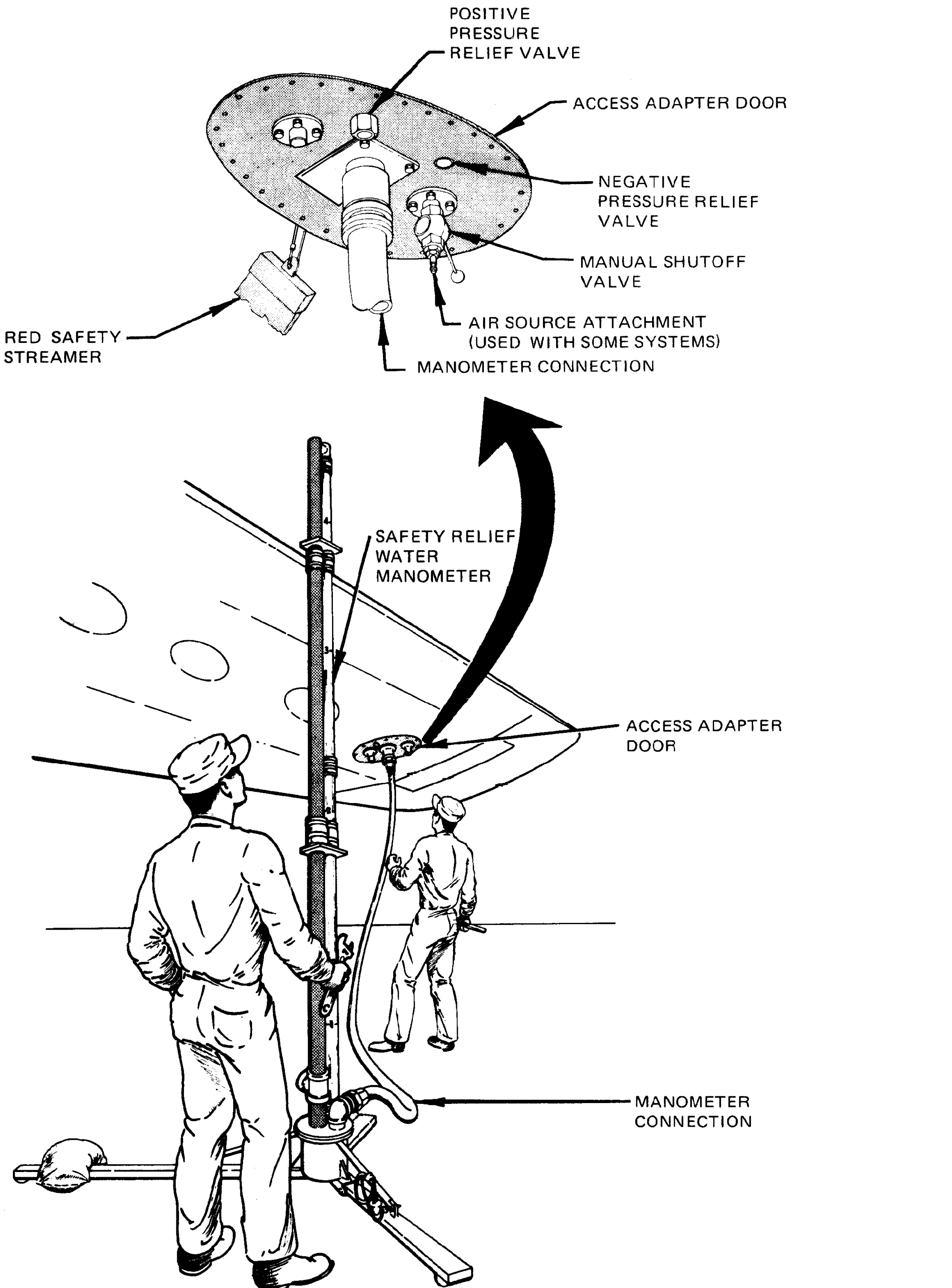


Figure 6-21. Pressure Test Method

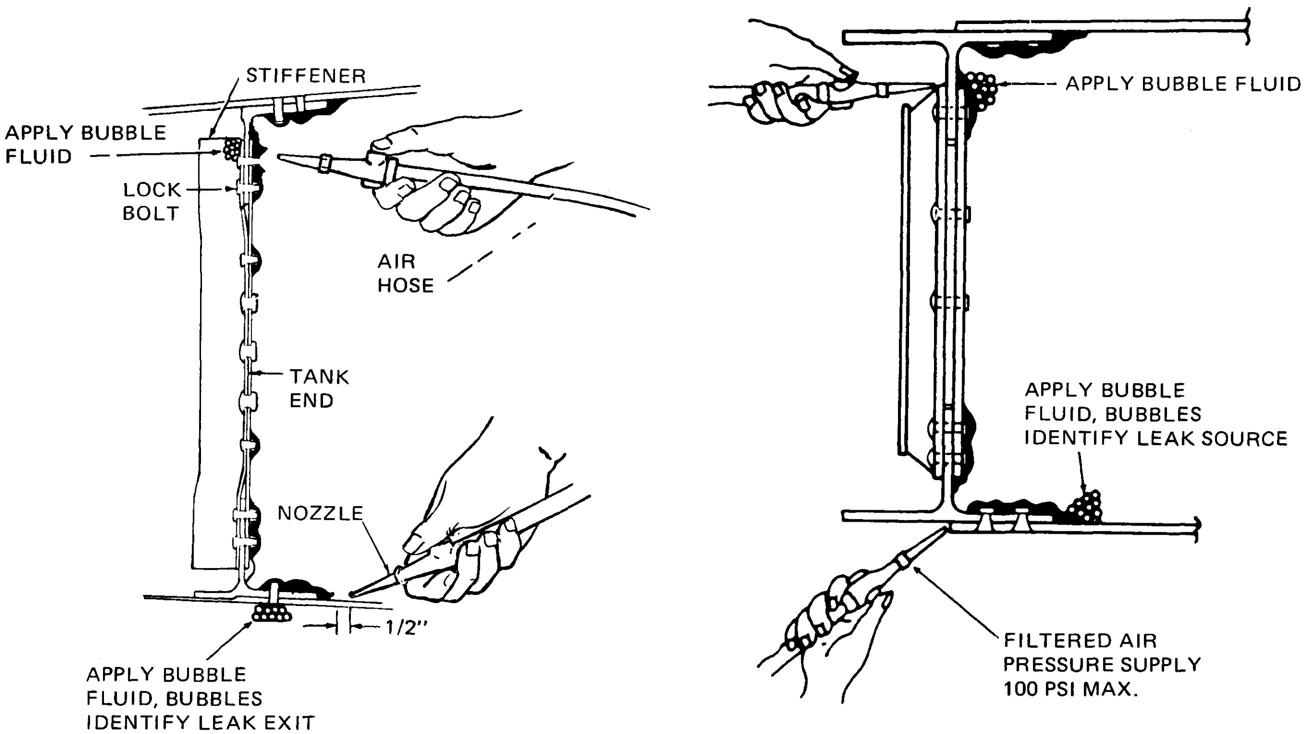


Figure 6-22. Blow Back Method

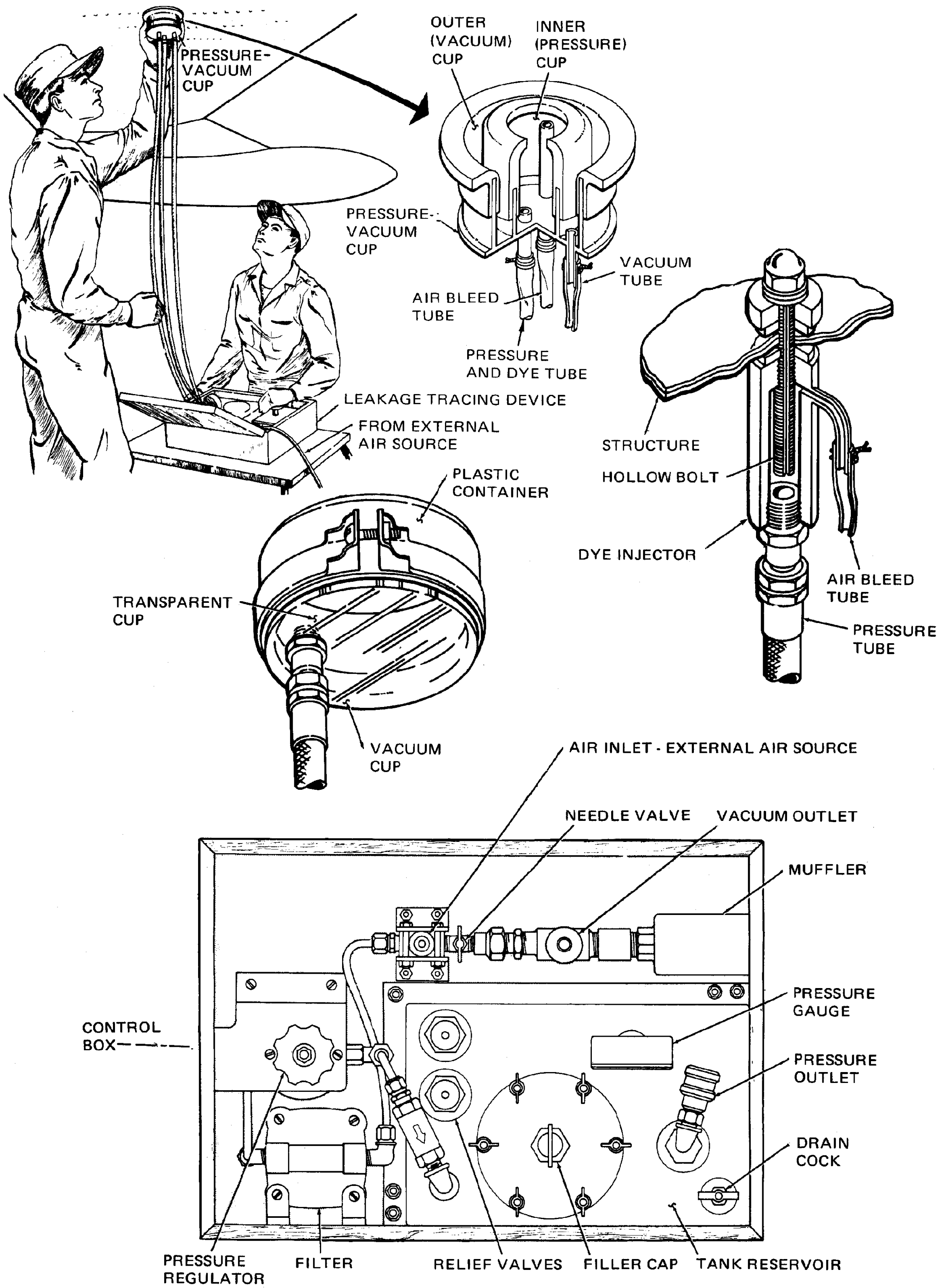


Figure 6-23. Dye Injection Method

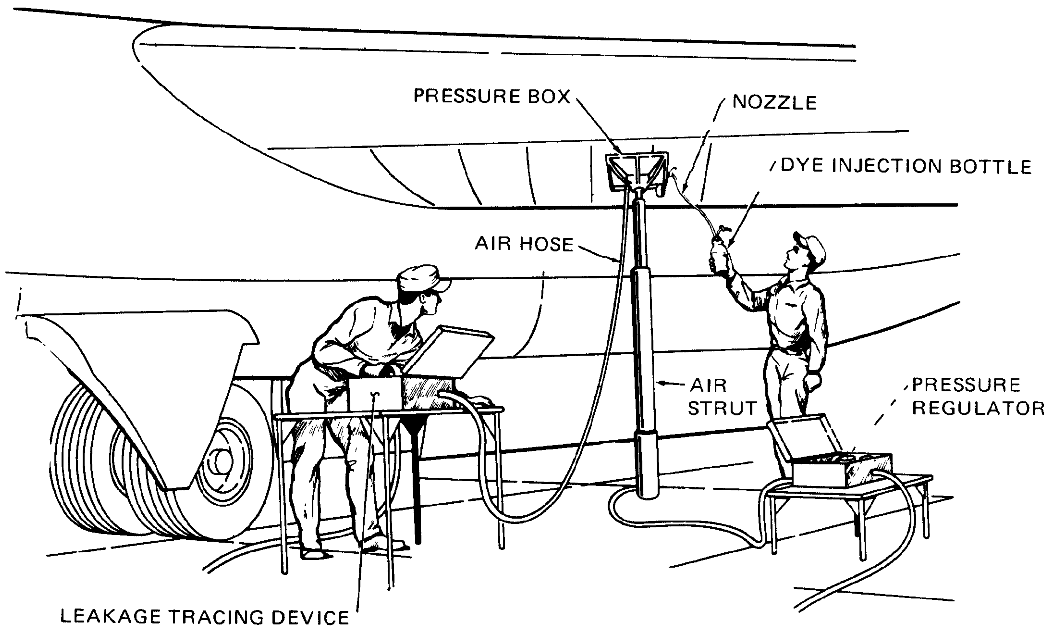
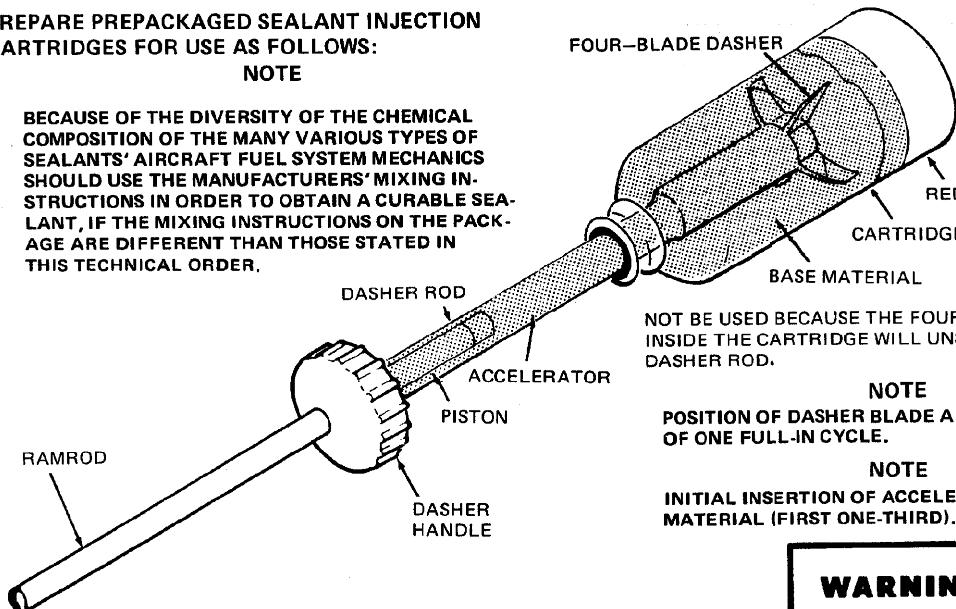


Figure 6-24. Use of Pressure Box for Dye Injection

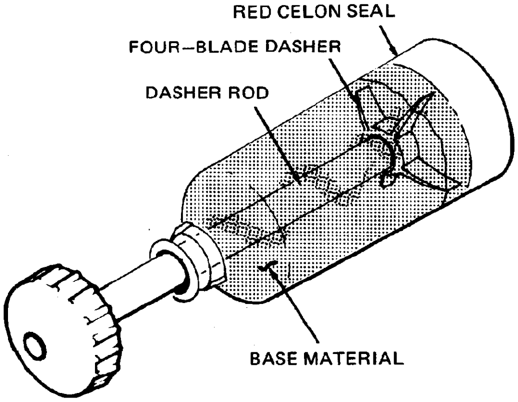
PREPARE PREPACKAGED SEALANT INJECTION CARTRIDGES FOR USE AS FOLLOWS:

NOTE

BECAUSE OF THE DIVERSITY OF THE CHEMICAL COMPOSITION OF THE MANY VARIOUS TYPES OF SEALANTS' AIRCRAFT FUEL SYSTEM MECHANICS SHOULD USE THE MANUFACTURERS' MIXING INSTRUCTIONS IN ORDER TO OBTAIN A CURABLE SEALANT, IF THE MIXING INSTRUCTIONS ON THE PACKAGE ARE DIFFERENT THAN THOSE STATED IN THIS TECHNICAL ORDER.



1. WEAR SAFETY GLASSES.
2. HOLD CARTRIDGE, GRASP DASHER ROD AND PULL BACK APPROXIMATELY ONE INCH. USE EVEN PRESSURE, DO NOT USE FORCE, TAP, POUND OR JOLT RAMROD IF PISTON DOES NOT BREAK LOOSE READILY.
3. INSERT RAMROD INTO HOLLOW OF DASHER ROD, BREAK PISTON LOOSE AND INJECT ABOUT 1/3 OF THE CONTENTS INTO THE CARTRIDGE. THE RAMROD WILL BE FULLY INSERTED INTO THE DASHER ROD WHEN ALL OF THE ACCELERATOR HAS BEEN FORCED INTO THE CARTRIDGE.
4. REPEAT STEPS 2 AND 3 UNTIL ALL OF THE CONTENTS OF THE ROD ARE EMPTIED INTO THE CARTRIDGE. THEN REMOVE RAMROD.
5. REMOVE AND DISCARD RAMROD.
6. BEGIN MIXING OPERATION BY ROTATING DASHER ROD IN A CLOCKWISE DIRECTION WHILE SLOWLY MOVING DASHER ROD TO FULL OUT POSITION. THE MIXING MUST BE DONE BY A CLOCKWISE ROTATION OF THE DASHER ROD. COUNTERCLOCKWISE ROTATION MUST NOT BE USED BECAUSE THE FOUR-BLADE DASHER INSIDE THE CARTRIDGE WILL UNSCREW FROM THE DASHER ROD.



NOTE

POSITION OF DASHER BLADE AFTER COMPLETION OF ONE FULL-IN CYCLE.

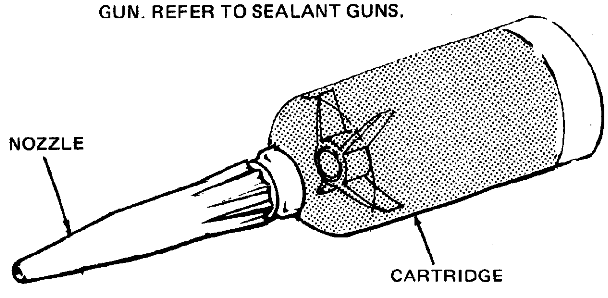
NOTE

INITIAL INSERTION OF ACCELERATOR INTO BASE MATERIAL (FIRST ONE-THIRD).

WARNING

THE CARTRIDGE SHALL BE HELD FIRMLY, BUT SHALL NOT BE SQUEEZED AS THE DASHER BLADES CAN SEVERELY DAMAGE THE HAND.

7. CONTINUE CLOCKWISE ROTATION AND SLOWLY MOVE DASHER ROD TO FULLY IN POSITION. A MINIMUM OF FIVE FULL CLOCKWISE REVOLUTIONS MUST BE MADE FOR EACH FULLY OUT STROKE AND FOR EACH FULLY IN STROKE OF THE DASHER ROD. MIX 5 MINUTES OR 50 CYCLES.
8. END MIXING ACTION WITH DASHER ROD IN FULL OUT POSITION.
9. WHILE HOLDING CARTRIDGE IN AN UPRIGHT POSITION, UNSCREW DASHER ROD BY GRIPPING DASHER BLADES IN AREA OF RED CELON SEAL AND TURNING DASHER ROD COUNTERCLOCKWISE.
10. SCREW NOZZLE INTO CARTRIDGE IF SEALANT FILLETING GUN IS TO BE USED.
11. REMOVE RED CELON SEAL AND TEST SEALANT TO INSURE THOROUGH MIXING ACTION HAS BEEN COMPLETED. IF NOT, DISCARD AND REPEAT PROCEDURES WITH NEW CARTRIDGE.
12. INSERT CARTRIDGE INTO APPLICABLE SEALANT GUN. REFER TO SEALANT GUNS.



NOTE

POSITION OF DASHER BLADE AFTER COMPLETION OF MIXING AND REMOVING OF DASHER ROD.

Figure 6-25. Hand Mixing of Sealant Kit

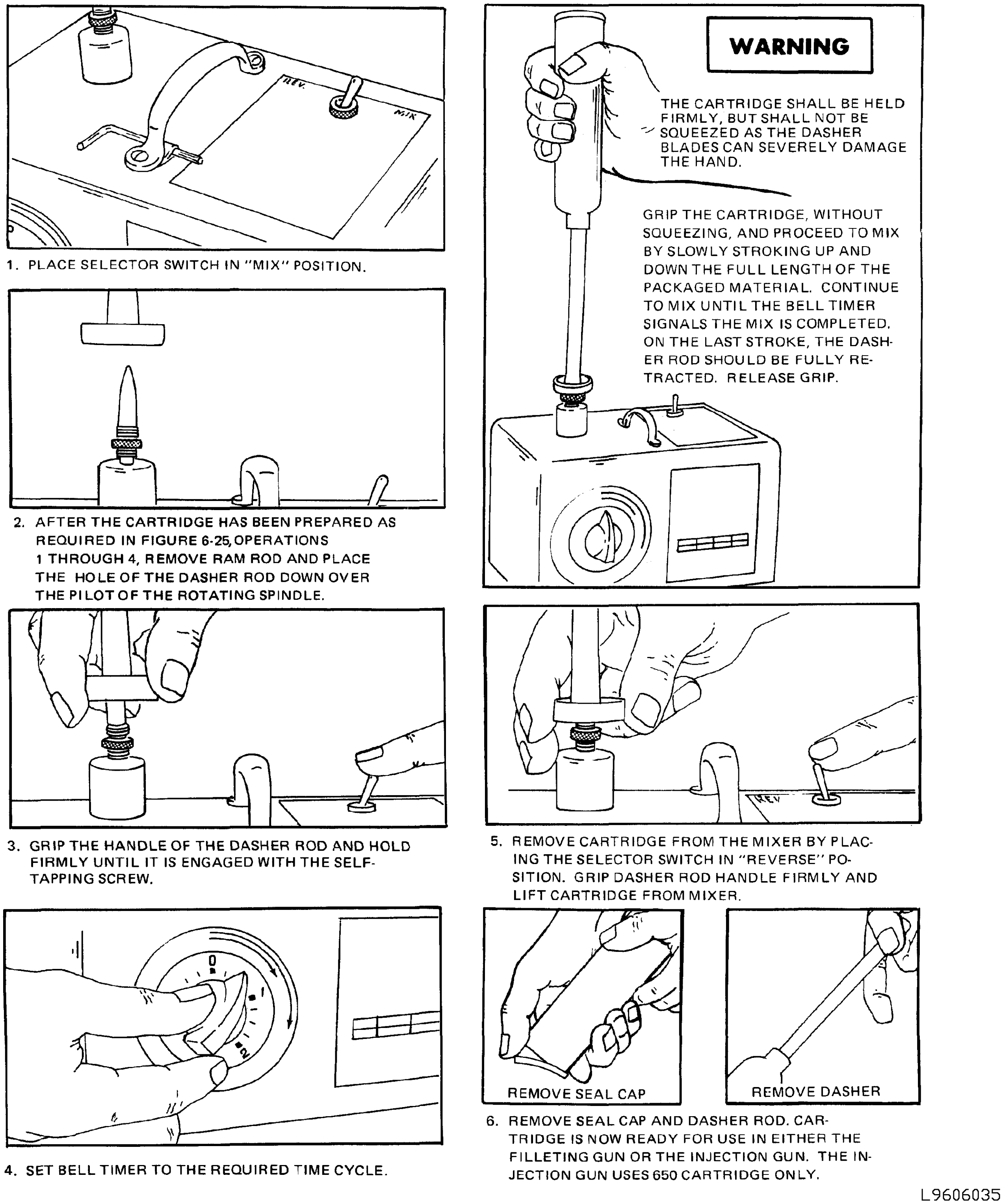


Figure 6-26. Machine Mixing of Cartridges

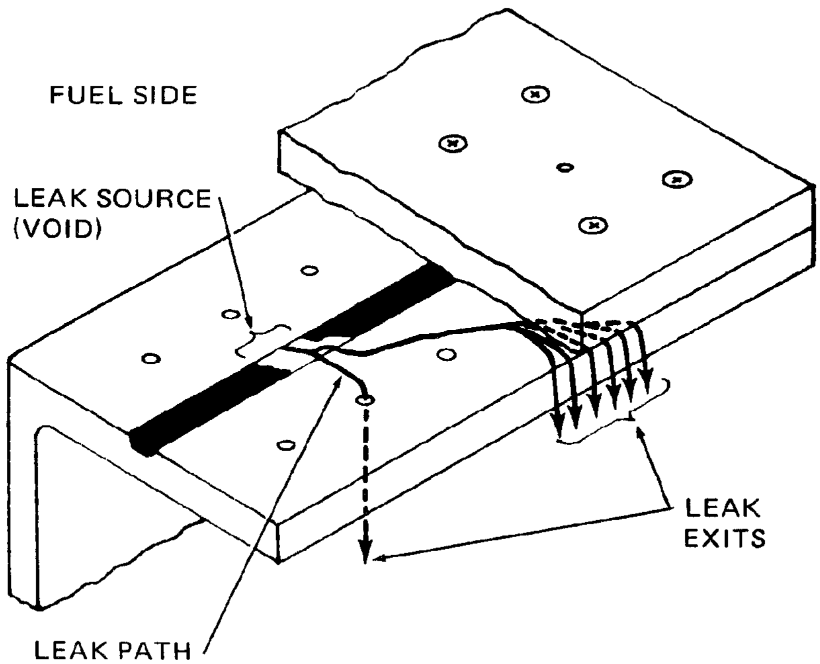


Figure 6-27. Void in Non-Curing Sealant Groove

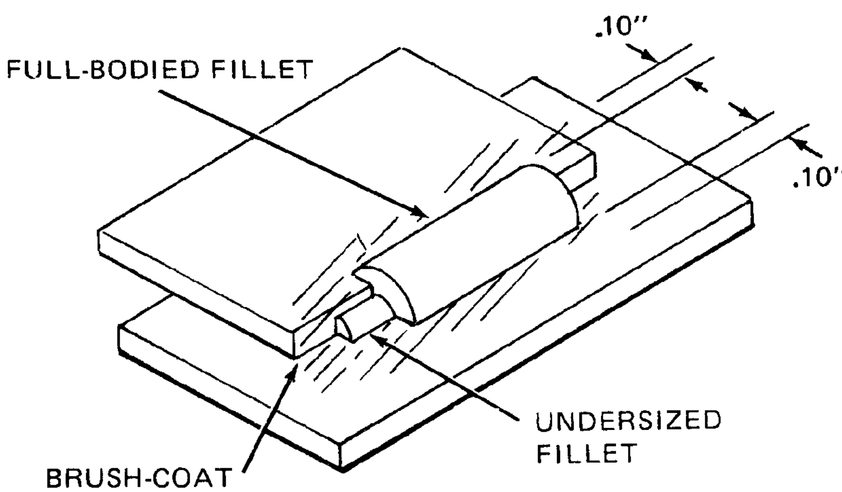


Figure 6-28. Two Bead Fillet

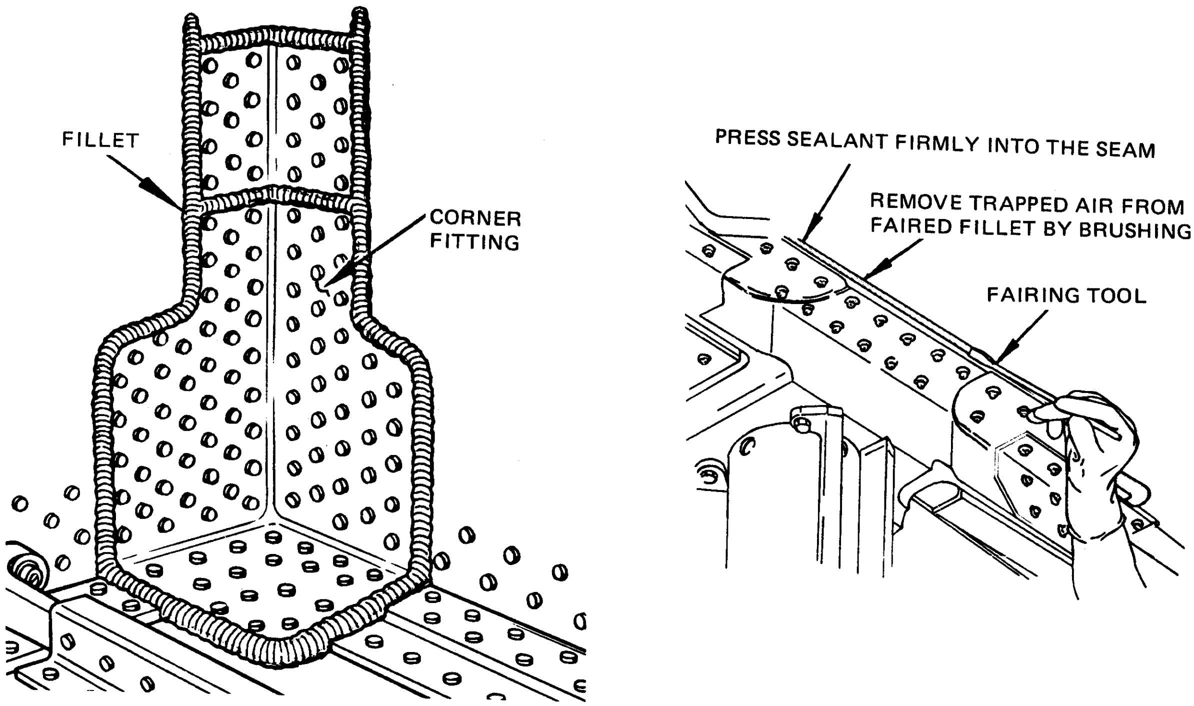
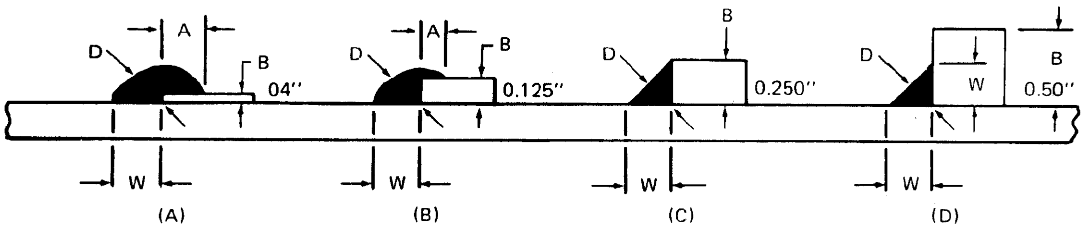
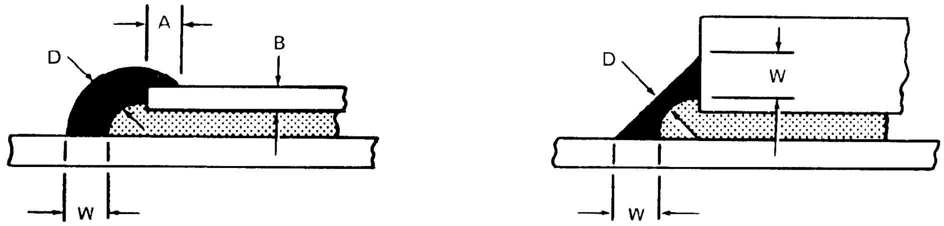


Figure 6-29. Typical Fillet Seals



D = 0.15" TO 0.20"
W = 0.25" TO 0.37"

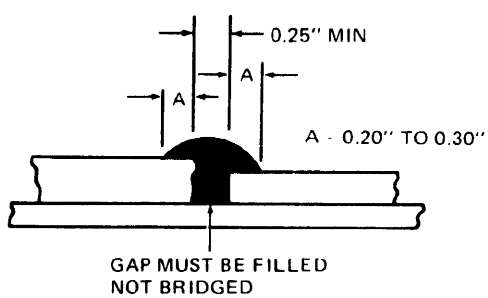


D = 0.15" TO 0.20"
W = 0.25" TO 0.37"

NOTE

"A" IS DEFINED BY FORMULA A + B W, EXCEPT A ZERO WHEN B = 0.25" OR MORE

CADMIUM PLATED PARTS SHOULD BE ISOLATED FROM CURING TYPE SEALANTS WITH APPROPRIATE TOPCOAT.



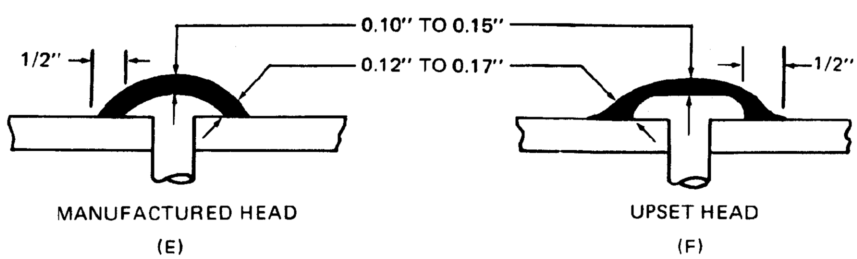
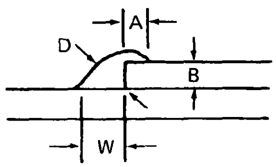


Figure 6-30. Typical Fillet Dimensions (Sheet 1 of 2)



C-140 (LOCKHEED)
W = 3/16" TO 1/4"
A = 1/16" TO 1/8"
D = 1/8" MIN
B = LESS THAN 1/4"

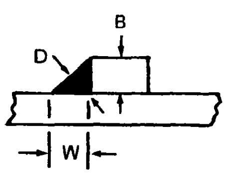
F-8 (VOUGHT)
W = 0.12" TO 0.25"
A = 0.06" TO 0.12"
B = LESS THAN 0.15"

C-5A (LOCKHEED)
W = 1/2" = NOMINAL, 3/8" = MIN
A = 1/4" = NOMINAL, 3/16" = MIN
D = 1/4" = MAX
B = 1/4" = MAX

L-1011 (LOCKHEED)
W = 3/16" TO 1/4"
A = 1/16" TO 1/8"
D = 1/8" MIN
B = 1/3" MAX

B-1 (ROCKWELL)
W = 0.25" MIN, 0.35" AVERAGE
A = 0.12" MIN
D = 0.12" MIN
B = LESS THAN 0.15"

DOUGLAS (ALL MODELS)
W = 1/4" MIN
A = 1/4" MIN



C-140 (LOCKHEED)
W = 3/8" TO 1/2"
B = 1/4" TO 1/2"
D = 3/16" MIN

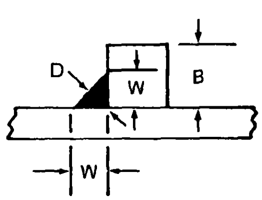
F-8 (VOUGHT)
W = 0.12" TO 0.25"
B = 0.15" MIN

C-5A (LOCKHEED)
W = 1/2" = NOMINAL, 3/8" = MIN
B = 1/4" = MIN
D = 1/4" = MIN

L-1011 (LOCKHEED)
W = 1/4" TO 3/8"
B = 1/8" MIN
D = 1/8" MIN

DOUGLAS (ALL MODELS)
W = 1/4" MIN
B = 1/4" MIN

C-130 (LOCKHEED)
W = 1/4" = MIN, 3/8" = AVERAGE
D = 1/8" = MIN



C-140 (LOCKHEED)
W = 3/8" TO 1/2"
D = 3/16" MIN

L-1011 (LOCKHEED)
W = 1/4" TO 5/8"
D = 1/8" MIN

C-5A (LOCKHEED)
W = 1/2" = NOMINAL, 3/8" = MIN
D = 1/4" = MIN

DOUGLAS (ALL MODELS)
W = 1/4" MIN

F-8 (VOUGHT)
W = 0.12" TO 0.25"

Figure 6-30. Typical Fillet Dimensions (Sheet 2)

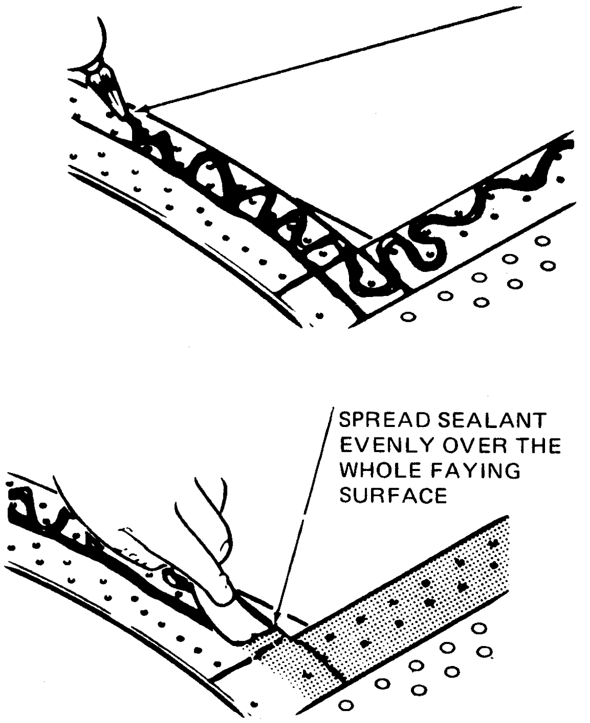


Figure 6-31. Applications of Faying Surface Sealant

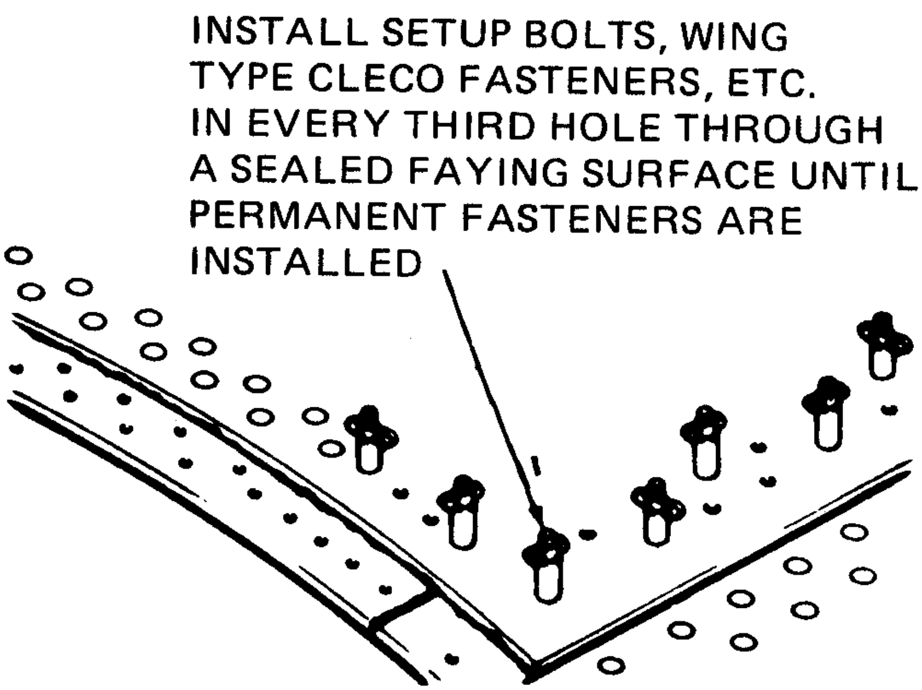


Figure 6-32. Faying Surface Seal Assembly

CHAPTER 7
FUEL CELLS

7.1 PURPOSE.

This chapter describes fuel cells, fittings, authorized repair methods, inspections, storage, packaging and removal and installation procedures.

7.2 GENERAL.

7.2.1 A fuel cell is a flexible bag contoured to the shape of a particular cavity. Cells are manufactured in three basic types, self-sealing, bladder, and combination (part bladder and part self-sealing). Fuel cell cavities shall be fuel tight. Leaks in cell cavities shall be repaired in accordance with the aircraft technical manuals or Chapter 6.

7.2.2 The purpose of cell repair is to return a cell to a serviceable condition, to restore its ability to carry the maximum load permitted, and to allow the cell to perform all functions for which it is designed.

7.3 CELL CONSTRUCTION.

7.3.1 Self-Sealing Cells.

7.3.1.1 A self-sealing cell is designed to temporarily seal itself when punctured. The sealing action reduces fire hazard and minimizes fuel loss. The cell must be repaired to retain its self-sealing capability. There are four primary layers in a self-sealing cell an inner liner of Buna-N synthetic rubber or rubber coated fabric; a nylon barrier film; semi-cured natural rubber sealant; a retainer of woven cord usually nylon, rayon or cotton. Cells may contain more than the four individual layers but the added layers will fall into one of the four general classifications. Functions for each of the four general classifications of layers are: the inner liner protects the nylon barrier; the nylon barrier contains the fuel and prevents diffusion through the cell wall; the sealant remains dormant until contacted by fuel, when contacted by fuel the sealant swells and closes the opening; the fabric material strengthens the cell and protects the nylon barrier.

7.3.1.2 The standard and lightweight construction are shown in Figure 7-3. In this construction the inner liner is made of nylon. The sealant is placed on the cell in two layers, a layer or layers of cord fabric placed between the two layers of sealant, a layer or layers of cord fabric placed on the exterior of the cell, and an outside lacquer coating which must remain fuel resistant for 72 hours.

7.3.1.3 The sealing function is brought about by a chemical and mechanical reaction which takes place when the cell is punctured. The mechanical reaction is the result of the property of the rubber to give under impact thereby limiting the damage to a small hole. The chemical reaction results in the swelling of the rubber material when in contact with fuel.

7.3.2 Bladder Cells.

7.3.2.1 The four basic types of bladder cells are those constructed of two or more plies of rubber coated fabric; those constructed of a combination of rubber coated fabric and Buna-N gum; those constructed of all nylon fabric and those constructed of polyurethane coated nylon fabric over a polyurethane sprayed inner liner. Bladder cells are lightweight and are not self-sealing. There are three primary layers in a bladder cell an inner liner of Buna-N synthetic rubber or rubber coated fabric; a nylon barrier film; a retainer of woven cord usually nylon, rayon or cotton. Cells may contain more than the three individual layers but the added layers will fall into one of the three general classifications. Functions for each of the three general classifications of layers are: the inner liner protects the nylon barrier; the nylon barrier contains the fuel and prevents diffusion through the cell wall; the fabric material strengthens the cell and protects the nylon barrier.

7.3.3 Combination Cells.

These cells consist of bladder and self-sealing cell construction. Most are usually self-sealing on the bottom and aft sections only.

7.3.4 Fittings.

There are three general types of fittings used on fuel cells

7.3.4.1 Rubber Face. This fitting has a ring of metal molded into the opening. It may be fully molded rubber or combined rubber and fabric. A seal is made by compression of the rubber faces between the cell and its mating part.

7.3.4.2 Compression. This fitting is used on bladder cells and consist of two metal rings. The cell openings are bolted between the rings to create a seal.

7.3.4.3 Metal-to-Metal. This fitting consist of a metal ring molded into the cell opening, which leaves the seal side of the metal ring exposed. A seal is made by using O-rings between the metal surfaces of the cell fitting and its mating part.

7.4 FUEL CELL HANDLING.

7.4.1 General.

7.4.1.1 Fuel cells are subject to various kinds of damage during normal handling. Care shall be taken when handling cells as they are easily damaged during uncrating, preparation for installation, during installation, removal from aircraft, and packing. All work surfaces used for fuel cell repair shall be clean, smooth, and padded. Cell handling should be kept to a minimum to avoid damaging the cell.

7.4.1.2 Never lift, move, or carry a cell by its fittings. Using fittings as lifting or handling points can damage the fittings.

7.4.1.3 Do not unnecessarily collapse or fold a cell as this may damage the nylon liner.

7.4.1.4 Do not drag or tumble a cell as this could damage the cell exterior.

7.4.1.5 Make sure work areas are clear of foreign objects which could damage the cell.

7.4.1.6 Use care when uncrating and crating cells to avoid damaging the cells.

7.4.2 Bladder Cell Handling. Bladder cells and beaded fitting cells are collapsed and folded prior to being placed in shipping and storage containers. Additional protection is provided beaded fitting cells by the installation of a split hose over the bead and by collapsing the cell over a fiberboard tube with a minimum diameter of six inches. The following precautions shall be followed when folding and unfolding bladder cells

7.4.2.1 Never fold or unfold a cell if its temperature is below 45°F. Use an approved heater to heat the cell and cell cavity. The optimum folding temperature for a cell is 70°F.

7.4.2.2 Always fold and unfold cells on clean, smooth, padded surfaces that are covered with canvas and waxed paper or rubberized fabric.

7.4.2.3 New cells that are boxed or crated and stored for more than a year may shrink. These cells should be soaked in warm water prior to air testing and installation.

7.4.2.4 Do not fold cells abusively or by air evacuation.

7.4.2.5 Install cell fitting protector rings as required by the aircraft technical manuals. Install protector rings prior to clasping the cell.

7.4.2.6 Do not rest cell on sharp objects, table edges, table corners or cavity edges.

7.4.2.7 Do not place heavy objects on cells.

7.4.2.8 Place protective caps on metal fittings that extend from the cell, when cell is out of cavity.

7.4.3 Self-Sealing Cell Handling. The following precautions shall be followed when folding and unfolding self-sealing cells

7.4.3.1 Never fold or unfold a cell if its temperature is below 45°F. Use an approved heater to heat the cell and cell cavity.

7.4.3.2 Always fold and unfold cells on clean, smooth, padded surfaces that are covered with canvas and waxed paper or rubberized fabric. One hour is the maximum time permitted for a cell to remain collapsed or folded. Collapse or fold just prior to installation or removal.

7.4.3.3 Do not fold cells abusively or by air evacuation.

7.4.3.4 Install cell fitting protector rings as required by the aircraft technical manuals. Install protector rings prior to clasping the cell.

7.4.3.5 Do not rest cell on sharp objects, table edges, table corners or cavity edges.

7.4.3.6 Do not place heavy objects on cells.

7.4.3.7 Place protective caps on metal fittings that extend from the cell, when cell is out of cavity.

7.4.3.8 Self-sealing cells are not collapsed for shipping or storage. They are shipped in their normal configuration.

7.4.3.9 Cells which have been improperly collapsed, stored or have for some other reason taken on a permanent crease may be salvaged by placing the cell in an air circulating oven set to 150°F. Pour warm water over the outside and inside of cell. The heat and moisture will soften the rubber and allow movement without damaging the nylon barrier. After one hour gradually stretch the cell and install internal supports. When the cell is restored to its normal shape allow the soak to continue for a total of four hours at 150°F. Remove the cell from the oven and air soak at room temperature for 20 hours before air testing and inspection.

7.4.4 Cell Removal.

7.4.4.1 Purge, drain, remove foam and depuddle cell in accordance with Chapter 5.

7.4.4.2 Ensure cell and cavity temperature is a minimum of 45°F for bladder cells and 70°F for self-sealing cells. Use a heater as necessary.

7.4.4.3 Remove cells in order beginning with Cell No. 1 or individually as required.

7.4.4.4 Disconnect all lines and fittings. Place all manifolds, hardware, components, etc., in a clean, dry area. Cap lines and components as necessary. Mark and inspect components as necessary.

7.4.4.5 Untie and remove all lacing and disconnect all hangers or retainer rods.

7.4.4.6 Fold cell in accordance with aircraft technical manual and paragraph 7.4.

7.4.4.7 Carefully remove cell from cavity. Do not force cell from cavity. If cell hangs up recheck to ensure fittings, hangars, and etc., have been removed.

7.5 FUEL CELL PRESERVATION, PACKING, PROTECTION, PACKING, AND STORAGE.

7.5.1 Cell Preservation.

7.5.1.1 Vithane and Other Polyurethane Self-Sealing and Bladder Cells. Clean the interior and exterior of the cell with soap, specification P-S-560, and warm water. rinse with clear, warm water.

7.5.1.2 Rubber or Synthetic Rubber Self-Sealing and Bladder Cells. Fuel has the tendency to extract the plasticizer from the rubber inner liner of a fuel cell. The loss of plasticizer is not detrimental to a cell as long as fuel remains in the cell. When fuel is drained from the cell the cell will dry and cracking or checking can occur. To prevent this type of failure apply a thin coating of a mixture containing 80 percent JP-5 and 20 percent oil, MIL-L-6081 Grade 1010, or VV-L-825, to the interior of the cell. If the cell is to be packaged and turned into supply or remain uninstalled for more than 72 hours apply a thin coat of 100 percent oil, MIL-L-6081 Grade 1010, or VV-L-825 in accordance with TO 00-85A-03-1. Oil may be applied by wiping or fogging. Excess oil shall be wiped-up with cheesecloth.

7.5.2 Cell Packaging.

7.5.2.1 Short-Term Storage (Less than 60 Days). Cover all openings and fittings with cushioning material specification, A-A-549, or barrier material MIL-B-121, Grade A, and secure with tape, MIL-T-22085, Type II. Wrap the cell in cushioning material or barrier material and place in a suitable container to prevent damage.

7.5.2.2 Long-Term Storage or Return to Supply. Package all cells in accordance with T.O. 00-85A-03-1.

7.5.3 Storage. All packaged cells should be stored in a dry area,protected from direct sunlight.

7.5.4 Periodic Inspections. Fuel cells are an assembly of items made from age sensitive elastomeres which are subject to deterioration by oxygen, ozone, sunlight, heat, rain, and similar other factors experienced in normal storage or use. Cells taken from storage should be thoroughly inspected prior to installation in the aircraft. All fuel cells in storage should be reinspected at two year intervals. If cells are installed in the aircraft they should be thoroughly inspected during depot maintenance.

7.6 FUEL CELL INSPECTION.

7.6.1 Inspection procedures are to establish uniform inspection procedures for cells and fittings. These standards shall be used by all personnel engaged in inspecting fuel, oil, and water-alcohol cells. When possible cells and self-sealing surfaces should be inspected prior to removal to eliminate unnecessary removals and handling. Serviceable cells should be stenciled with the word ''SERVICEABLE'', inspecting organization's symbol, and date. The AFTO 95 shall be annotated as necessary.

7.6.2 Diagnostic Information. The following information can help prevent incorrect diagnosis of fuel cell leakage.

7.6.2.1 Investigation of reports, stating that fuel was seeping through a cell because of pinholes or porous liners, revealed the cell was often good, but was saturated with fuel trapped in the cavity. No cell is intended to be completely impervious to fuel from the outside. When fuel is trapped in the cavity some of the fuel will be absorbed by the outer ply of fabric.

7.6.2.2 JP fuels will not evaporate as readily as aviation gasoline. Cell fabric will stay wet for several days. This often causes persons unfamiliar with bladder cell construction diagnose the condition as fuel seepage. The area may appear dry and when pressurized or tested with fuel will appear to seep. This condition is caused by the internal pressure on the fabric which causes the fuel to ooze to the surface. This condition is called weeping and is not an indication of a leaky cell.

7.6.2.3 Pinholes are sometimes found to be caused by minute imperfections or foreign matter in the cell inner liner. In the coating process the rubber may not be perfectly smooth; small particles may be embedded in the rubber; or there may be small indentation in the rubber from imperfection in the mold. This may be acceptable if the nylon barrier is not broken.

7.6.2.4 A condition often reported in new cells is delamination. Acceptance standards allow a certain amount of loose liner lap, channel and blistering. Test and service experience prove that these conditions will not affect serviceability if the allowable limits are not exceeded.

7.6.2.5 New cells have been reported as having ozone checked liners. Conditions which make the liners in new cells look deteriorated are almost always minor manufacturing imperfections caused by crazing or cracking of the coating used on the building forms. The outline of the crazing on the molds is easily transferred to the rubber material of the cell.

7.6.2.6 Fried or scarred inner liners are usually found in cells with gum liners. This condition is caused by small amount of air or solvent vapor being trapped between the liner and the building form. This air or vapor cannot escape due to the pressures applied during manufacturing and causes depressed areas to be formed on the soft inner liner. This condition will not progress after the manufacturing process is complete.

7.6.2.7 Self-supporting, non-metallic fuel cells frequently are found with separation between the self-sealing portion and the hard outer shell. The basic design of principal of these cells is for the cell to delaminate easily around the area of bullet entry. To make sure of this delamination, the cement used between the cell and the shell does not afford permanent adhesion. These separations may be ignored if the delaminations do not substantially affect cell capacity.

7.6.2.8 Activation of self-sealing cells may be from either internal or external fuel. Proper evaluation of the cell is required to determine if a pinhole, wicking or external fuel contact has caused the activation.

7.6.2.9 Fuel bubbles that accumulate between the interior surface of the fuel cell and the supplementary metallic supports should not be considered defects provided the structure of the fuel cell remains unbroken.

7.6.3 Cleaning Prior to Inspection.

7.6.3.1 Materials Required. Clean static free absorbent wiping cloths, solvent (P-D-680, Type II or Type III), liquid soap (P-S-560), hot water (not to exceed 120°F).

7.6.3.2 Prior to inspection fuel cells shall be cleaned as required using cloth and cleaning solvent. Soap and hot water may be used for large scale cleaning. All soap residue shall be removed with clear water. Cells shall be dried thoroughly after cleaning.

7.6.3.3 Self-Sealing Cell Drying. Self-sealing cells shall be drained and thoroughly dried as soon as possible after damage is found to prevent excessive activation of the sealant. Drying may be accelerated by placing the cell in a warm area (80°F) and flowing air through the cell. Higher temperatures will dry the fuel soaked sealant nearest the damage and trap fuel in the sealant. Trapped fuel will cause separation and breakdown of the sealant area. To prevent this condition, the edge of the damage shall be spread slightly with wood peg to allow fuel vapors to escape from the sealant. This type of damage requires several days to properly dry.

7.6.4 Inspection Procedures and Criteria.

7.6.4.1 Characteristics have been classified according to their relative importance to cell serviceability. Fuel cell inspectors must rely on visual inspection and knowledge of fuel cell construction. Stand testing with fuel is the most positive method of testing self-sealing cells and should be accomplished if possible.

7.6.4.2 Prior to installation in the aircraft inspect the cell in accordance with paragraph 7.6.5. and paragraph 7.6.6. Cells installed in the aircraft shall be inspected in accordance with paragraph 7.6.7 and paragraph 7.6.8. The criteria for self-sealing and bladder cell shall be used when inspecting multiplex, self-sealing, and combination cells.

7.6.4.3 Cells not meeting the inspection criteria shall be repaired to acceptable limits or returned to supply as repairable items. Condemnation of fuel cells shall be determined by an ALC fuel cell repair shop.

7.6.5 Inspection of new and Removed Self-Sealing Cells.

7.6.5.1 Self-Sealing Cell Interior Inspection.

a. Loose Liner at Throat of Fitting. 1/2-inch looseness in width around circumference at throat of fitting (Figure 7-5). Looseness to be trimmed at time of repair up to 1/4-inch width if 1-inch bond is maintained between laps. Vertical edge looseness is acceptable.

b. Edge Looseness at Liner Lap. 1/4-inch width if 1-inch bond is maintained between laps.

c. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 15 percent of patch width. Blisters or separations other than in edge area allowable up to 1/2-inch square, 6 inches apart.

d. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 15 percent of individual areas if 1/2-inch bond is maintained around edge (Figure 7-6).

e. Blisters Between Liner and Fitting Flange. 1/2-inch maximum dimension; maximum one per liner foot and four/fitting if 1-inch bond is maintained (Figure 7-5).

f. Damaged Coating on Accessories (Metal or Rubber). Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with T.O. 1-1-691.

g. Checking Due to Weather, Ozone, Dry Cracking, or Surface Imperfections in Liner (Figure 7-9). Not acceptable.

h. Blisters in Liner Lap. 1/4-inch maximum dimension; no more than one per liner foot of splice with maximum of five in any 5-foot length of splice (Figure 7-7).

i. Blisters, Delaminations or Ply Separations. 1-inch square maximum dimension if there is a 6-inch bond between blisters.

j. Channels in Inner Liner Laps. 1/4-inch by 3-inch maximum dimension with a maximum of one in any 5 lineal foot of splice (Figure 7-7).

k. Channels Around Entire Outer Edge of Fitting Flange. 1/4-inch maximum width (Figure 7-5).

l. Channels at Tapered Construction Step-Off Area or Edge of Lap Splices of any Ply. 1/4-inch maximum width of entire length of lap (Figure 7-8).

m. Open End Channels in Three-Ply Liner Overlaps or Tailored Corners. 1/4-inch by 3-inch maximum dimension if 1-inch minimum bond is maintained between end of channel and sealant.

n. Cuts or Tears in Inner-Liner. Not acceptable.

o. Buffing Through Inner-Liner. Not acceptable.

7.6.5.2 Self-Sealing Cell Exterior Inspection.

a. Blisters or Ply Separation Between any Plies Except Liner and Sealant. 1-inch maximum dimension.

b. Skim Coat Paint Blister. Acceptable.

c. Loose Hangar Straps or Hangar Attaching Points. Acceptable up to 15 percent looseness total area if 1/4-inch bond is maintained around edge.

d. Checking due to Weather, Ozone, Dry Cracking, or Surface Imperfections other than Fittings. Acceptable.

e. Damage Through Outer Cord or Fabric Ply. Not acceptable.

f. Channels or Bridging of Outer Plies at Cord or Fabric Splices. 1/2-inch maximum width, full length of splice (Figure 7-8).

g. Outer Ply Cuts or Splits Parallel to Cords Where Cords are not Damaged. Not acceptable, may cause activation.

h. Permanent Set or Crease. Not Acceptable.

i. Loose Liner at Throat of Fitting. 1-inch looseness in width around circumference at throat of fitting (Figure 7-5). Looseness to be trimmed at time of other repair up to 1/4-inch width if 1-inch bond is maintained between laps. Vertical edge looseness is acceptable.

7.6.5.3 Fully Rubber-Molded Fittings Inspection.

a. Gouges, Splits, or Deep Indentations on Sealing Surface. 1/16-inch maximum depth by 1/16 inch maximum length (Figure 7-11).

b. Weather Checking on Sealing Surface. Not acceptable (Figure 7-11).

c. Weather Checking on Outer Flange. Acceptable up to a depth of 1/16-inch depth.

7.6.5.4 Sealing Face without O-Ring Groove.

a. Burrs on Mating Surface. Not Acceptable.

b. Corrosion. Not acceptable.

c. Weather Checking on Outer Flange. Acceptable.

7.6.5.5 Sealing Face with O-Ring Groove.

a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.

b. Physical Damage to O-Ring Groove. Not acceptable.

c. Corrosion. Not acceptable.

d. Cement or other Foreign Material in O-Ring groove. Not acceptable.

e. Bent or Broken Fittings. Not acceptable.

f. Thread-Damaged Fittings. Not acceptable.

7.6.6 Inspection of New and Removed Bladder-Type Cells.

7.6.6.1 Bladder Cell Interior Inspection.

a. Loose Liner at Throat of Fitting. 1/2-inch looseness in width around circumference at throat of fitting, except Firestone construction on which 1/16-inch edge looseness is allowable (Figure 7-5). Vertical edge looseness is acceptable. This applies also to American Fuel Cell and Coated Fabrics Co. (AMFUEL).

b. Edge Looseness at Liner Lap. 1/4-inch width if 1-inch bond is maintained between laps, except Firestone construction 1052-6 on which 1/16-inch edge looseness is acceptable (T-33 aircraft only).

c. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 15 percent of patch total area. Blisters or separations other than in edge area allowable up to 15 percent of total area.

d. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 15 percent of individual areas if 1/4-inch bond is maintained around edge.

e. Blisters Between Fitting Flange and Adjacent Ply. 1/2-inch maximum dimension; maximum two per lineal foot and two per fitting if 1-inch bond is maintained (Figure 7-5).

f. Damaged Coating on Accessories (Metal, Rubber or Wood). Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with T.O. 1-1-691.

g. Checking Due to Ozone of Buna Rubber (Figure 7-9). Not acceptable.

h. Channels Between Liner Laps. 1-inch width by 1-inch length maximum dimension; one per liner foot with a maximum of five in any 8-foot length of splice (Figure 7-7).

i. Blisters Between Plies. 1-inch maximum dimension; minimum 3-inch bond between blisters, maximum one/foot square.

j. Channels in Liner Laps. 1/4-inch by 3-inch maximum dimension with a maximum of one in any 5 liner foot of splice (Figure 7-7).

k. Weather Checking on Fabric. Not acceptable.

l. Channels Around Entire Outer Edge of Fitting Flange. 1/4-inch maximum width around fitting flange (Figure 7-5).

m. Buffing Through Inner-Liner. Not acceptable.

n. Exposed Fabric. Acceptable if exposed fabric has no damaged cords.

o. Delamination Between Plies. 1-inch maximum dimension; one per 5 square foot of area, minimum 6-inch solid bond between delaminations.

p. Cuts, Holes, or Tears in Inner-Liner. Not acceptable.

7.6.6.2 Bladder Cell Exterior Inspection.

a. Skim Coat Blisters. Acceptable.

b. Lap Splice Edge Looseness. 1/4-inch by 3-inch maximum dimension with no more than one per linear foot if 1-inch bond is maintained.

c. Loose or Damaged Hangar Straps or Hangar Attaching Points. Acceptable up to 15 percent of component area if 1/4-inch solid bond is maintained around edge (Figure 7-12).

d. Loose Tapes, Corner Patches or Outside Non-Load Carrying Accessories. 1/2-inch maximum allowable looseness if it does not exceed 25 percent of total area.

e. Skim Coat Off Outer Ply. Acceptable if cords or fabric are not cut or broken.

f. Mislocated, Blistered, Split, or Weather Checked Tape. Acceptable; mission tape to be replaced.

g. Blisters or Looseness Between labels or Decals and Body of Cell. Acceptable.

h. Weather Checked or Surface Imperfections in Outer Ply or Reinforcements. Acceptable if fabric not damaged or broken.

i. Blistered, Loose or Missing Lacquer Coating. Acceptable.

j. Blisters Between fitting Flange and Adjacent Ply. 1/2-inch maximum dimension; maximum of two per linear foot and two per fitting if 1-inch bond is maintained Figure 7-5.

k. Delamination Between Plies. 1-inch maximum dimension; one per 5 square feet of area in any 5-foot area; minimum 6-inch solid bond between delaminations.

l. Blisters Between Outer Ply Laps. 1/2-inch width by 1-inch length maximum dimension; one per 5 linear feet of splice with a maximum of five in any 5-foot length of splice.

m. Blisters Between Plies In Cell Panels. 1/2-inch maximum dimension; minimum of 6-inch bond between blisters and no more than one per square foot of cell area.

n. Channels in outer ply laps. 1/4-inch width entire length of lap.

o. Looseness Around Outer Fitting Flange. 1/4-inch maximum around fitting flange (Figure 7-5) if 1-inch bond is maintained. Vertical edge looseness is acceptable.

p. Damage Through any Cord or Fabric Ply. Not acceptable.

q. Holes in Inner Liner. Not acceptable; confirm by pressure test.

7.6.6.3 Rubber Face Fittings.

a. Gouges, Splits, or Indentations on Sealing Surface. 1/16-inch depth by 1/16-inch length maximum dimension.

b. Weather, Ozone Checking of Surfaces Other than sealing Surface. Acceptable.

c. Weather, Ozone Checking of Sealing Surface. Not acceptable.

7.6.6.4 Sealing Surface without O-Ring Groove.

a. Scratches Within Sealing Area. Not acceptable (Figure 7-11).

b. Burrs on Mating Surfaces. Not acceptable (Figure 7-11).

c. Corrosion or Rust. Not acceptable.

7.6.6.5 Sealing Surface with O-Ring Groove.

a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.

b. Physical Damage to O-Ring Groove. Not acceptable.

c. Corrosion. Not acceptable.

d. Cement or other Foreign Material in O-Ring groove. Not acceptable.

e. Bent or Broken Fittings or Damaged Dome Nuts. Not acceptable.

f. Elongated or Torn Holes in Fitting Flange of Cells Using U.S. Rubber Removable Two-Piece Metal Compression Fittings. Acceptable if elongation or tear does not extend beyond outer or inner sealing groove of inner ring or over 1/2 the distance to the next hole; minimum of two holes in a row with these conditions.

g. Thread-Damaged Fittings. Not acceptable.

7.6.7 Inspection of Installed Self-Sealing Cells.

7.6.7.1 Self-Sealing Cell Interior Inspection.

a. Loose Collar at Throat of Fitting. 1-inch looseness in width around circumference at throat of fitting does not include the collar on a replaced fitting 9Figure 7-5).

b. Edge Looseness at Liner Lap. 1/2-inch width if remainder of bond is good (Figure 7-7).

c. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 20 percent of total area. Blisters or separations other than in edge area allowable up to 20 percent of total area.

d. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 20 percent of individual areas if 1/4-inch bond is maintained around edge (Figure 7-6).

e. Blisters Between Liner and Fitting Flange. 1/2-inch maximum dimension; maximum two per liner foot and three/fitting if 1-inch bond is maintained (Figure 7-5).

f. Damaged Coating on Accessories Metal or Rubber. Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with T.O. 1-1-691.

g. Checking Due to Weather, Ozone, Dry Cracking, or Surface Imperfections in Liner (Figure 7-9). Not acceptable.

h. Blisters in Liner Lap. 1/2-inch maximum dimension; with maximum of five in any 5-foot length of splice with a minimum 6-inch bond between blisters (Figure 7-9).

i. Blisters, Delaminations or Ply Separations. 1 1/2-inch maximum dimension if there is a 6-inch bond between blisters and not more than one per square foot of area.

j. Channels in Inner Liner Laps. 1/4-inch by 3-inch maximum dimension with a maximum of one in any 5-lineal foot of splice (Figure 7-7).

k. Channels Around Entire Outer Edge of Fitting Flange. 1/2-inch maximum width (Figure 7-5).

l. Channels at Tapered Construction Step-Off Area or Edge of Lap Splices of any Ply. 1/2-inch maximum width of entire length of lap (Figure 7-8).

m. Open End Channels in Three-Ply Liner Overlaps or Tailored Corners. 1/4-inch by 3-inch maximum dimension if 1-inch minimum bond is maintained between end of channel and sealant (Figure 7-7).

n. Cuts or Tears in Inner-Liner. Not acceptable.

o. Buffing Through Inner-Liner. Not acceptable.

p. Damaged Anchor Fittings. Maximum cut or worn area 25 percent of total dimension.

q. Activated Area. Not Acceptable.

r. Broken Stiffeners or Supports. Not acceptable.

7.6.7.2 Self-Sealing Cell Exterior Inspection.

a. Only accessible portions of cells will be inspected. Do not remove cells from aircraft for inspection.

b. Blisters or Ply Separation Between any Plies Except Liner and Sealant. 1 1/2-inch maximum dimension.

c. Skim Coat Paint Blister. Acceptable.

d. Loose Hangar Straps or Hangar Attaching Points. Acceptable up to 20 percent looseness total area if 1/4-inch bond is maintained around edge.

e. Loose or Damaged Tapes, Corner Patches or Other Outside Accessories. Acceptable if sealant is not activated.

f. Checking due to Weather, Ozone, Dry Cracking, or Surface Imperfections other than Fittings. Acceptable.

g. Damage Through Outer Cord or Fabric Ply. 1-inch maximum dimension.

h. Channels or Bridging of Outer Plies at Cord or Fabric Splices. 1/2-inch maximum width, full length of splice (Figure 7-10).

i. Outer Ply Cuts or Splits Parallel to Cords Where Cords are not Damaged. Acceptable if sealant is not activated.

7.6.7.3 Fully Rubber-Molded Fittings Inspection.

a. Gouges, Splits, or Deep Indentations on Sealing Surface. 1/16-inch maximum depth by 1/8 inch maximum length (Figure 7-11).

b. Weather Checking on Sealing Surface. Acceptable (Figure 7-11).

7.6.7.4 Sealing Face without O-Ring Groove.

a. Scratches Within Sealing Area. Not acceptable (Figure 7-11).

b. Burrs on Mating Surface. Not Acceptable.

c. Damage to Protective Coating. Acceptable.

d. Corrosion. Not acceptable.

7.6.7.5 Sealing Face with O-Ring Groove.

a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.

b. Physical Damage to O-Ring Groove. Not acceptable.

c. Corrosion. Not acceptable.

d. Cement or other Foreign Material in O-Ring groove. Not acceptable.

e. Bent or Broken Fittings. Not acceptable.

f. Thread-Damaged Fittings. Not acceptable.

7.6.8 Inspection of Installed Bladder-Type Cells.

7.6.8.1 Bladder Cell Interior Inspection.

a. Loose Liner at Throat of Fitting Except Sump-Type and Three-Plane Fittings. 1/2-inch looseness in width around circumference at throat of fitting, except Firestone construction on which 1/16-inch edge looseness is allowable if 1-inch bond is maintained (Figure 7-5). Vertical edge looseness is acceptable.

b. Loose Collar at Throat of Sump-Type and Three-Plane Fittings. 1/4-inch maximum looseness (Figure 7-13) and (Figure 7-14).

c. Edge Looseness at Liner Lap. 1/4-inch width if 1-inch bond is maintained between laps, except Firestone construction 1052-6 on which 1/16-inch edge looseness is acceptable (T-33 aircraft only).

d. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 25 percent of patch total area. Blisters or separations other than in edge area allowable up to 25 percent of total area.

e. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 25 percent of individual areas if 1/4-inch bond is maintained around edge.

f. Blisters Between Liner and Adjacent Ply. 1/2-inch maximum dimension; maximum two per liner foot and three per fitting if 1-inch bond is maintained (Figure 7-5).

g. Damaged Coating on Accessories Metal, Rubber or Wood. Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with T.O. 1-1-691.

h. Weather Checking. Not acceptable.

i. Blisters Between Liner Laps. 1/2-inch maximum dimension; maximum of five in any 5-foot length of splice with a minimum of 6-inch bond between blisters (Figure 7-7).

j. Blisters Between Plies. 1 1/2-inch maximum dimension; minimum 6-inch bond between blisters, maximum one per square foot of cell area.

k. Channels in Liner Laps. 1/4-inch by 3-inch maximum dimension with a maximum of one in any 5-lineal foot of splice (Figure 7-5).

l. Channels Around Entire Outer Edge of Fitting Flange. 1/4-inch maximum width around fitting flange (Figure 7-5).

m. Damaged Coating on Accessories Rubber, Metal, or Wood. Acceptable if corrosion is not present.

n. Exposed Fabric. Acceptable if exposed fabric has no damaged cords.

o. Split or Damaged Corner Reinforcements. Acceptable.

p. Cuts, Holes, or Tears in Inner-Liner. Not acceptable.

q. Delamination Between Plies. 1 1/2-inch maximum dimension; one per 5 square foot of area, minimum 6-inch solid bond between delaminations.

r. Broken Stiffeners or Supports. Not Acceptable.

7.6.8.2 Installed Bladder Cell Exterior Inspection.

a. Only accessible portions of cells will be inspected; they shall not be removed from the aircraft for inspection.

b. Skim Coat Blisters. Acceptable.

c. Loose or Damaged Hangar Straps or Hangar Attaching Points. acceptable up to 25 percent of component area if 1/4-inch solid bond is maintained around edge (Figure 7-12).

d. Loose Tapes, Corner Patches or Outside Non-Load Carrying Accessories. 1/2-inch maximum allowable looseness if it does not exceed 20 percent of total area.

e. Lap splice Edge Looseness. 3/8-inch by 3-inch maximum dimension, no more than 5 per linear foot.

f. Skim Coat Off Outer Ply. Acceptable if cords or fabric are not cut or broken.

g. Mislocated, Blistered, Split, or Weather Checked Tape. Acceptable.

h. Blisters or Looseness Between labels or Decals and Body of Cell. Acceptable.

i. Weather Checked or Surface Imperfections in Outer Ply or Reinforcements. Acceptable if fabric not damaged or broken.

j. Blistered, Loose or Missing Lacquer Coating. Acceptable.

k. Damage Through any Cord or Fabric Ply. Not acceptable.

l. Delamination Between Plies. 1 1/2-inch maximum dimension; one per 5 square feet of area in any 5-foot area; minimum 6-inch solid bond between delaminations.

m. Blisters Between Fitting Flange and Adjacent Ply. 1/2-inch maximum dimension; maximum of two per linear foot and three per fitting if 1-inch bond is maintained (Figure 7-5).

n. Blisters Between Outer Ply Laps. 1 1/2-inch maximum dimension; two per linear feet of splice with a maximum of five in any 5-foot length of splice.

o. Blisters Between Plies (In Cell Panels). 1 1/2-inch maximum dimension; minimum of 6-inch bond between blisters and no more than one per square foot of cell area.

p. Channels in Outer Ply Laps. 1/2 entire length of lap if 1-inch bond is maintained on outer edge.

q. Channels Around Entire Edge of Fitting Flange. 1/4-inch maximum width around fitting flange (Figure 7-5).

7.6.8.3 Vithane Cell Exterior Inspection (Installed Cells). Only accessible portions of cells will be inspected; they shall not be removed from the aircraft for inspection.

a. Skim Coat Blisters. Acceptable.

b. Separation Between Layers. 1/2-inch maximum dimension.

c. Slits, Holes, or Tears. Not Acceptable.

d. Damage Through cord or Fabric Ply. Not Acceptable.

e. Blisters or Looseness Between any Labels or Decals and Body of Cells. Acceptable.

f. Skim Coat Off Outer Ply. Acceptable.

g. Loose Edges. 1/2-inch maximum dimension.

h. Missing Coat. Not Acceptable.

7.6.8.4 Rubber Face Fittings.

a. Gouges, Splits, or Indentations on Sealing Surface. 1/16-inch depth by 1/8-inch length maximum dimension.

b. Weather, Ozone Checking of Surfaces Other than sealing Surface. Acceptable.

c. Weather, Ozone Checking of Sealing Surface. Not acceptable.

7.6.8.5 Sealing Surface without O-Ring Groove.

a. Scratches Within Sealing Area. Not acceptable (Figure 7-11).

b. Burrs on Mating Surfaces. Not acceptable (Figure 7-11).

c. Corrosion or Rust. Not acceptable.

7.6.8.6 Sealing Surface with O-Ring Groove.

a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.

b. Physical Damage to O-Ring Groove. Not acceptable.

c. Corrosion. Not acceptable.

d. Cement or other Foreign Material in O-Ring groove. Not acceptable.

e. Bent or Broken Fittings or Damaged Dome Nuts. Not acceptable.

f. Elongated or Torn Holes in Fitting Flange of Cells Using U.S. Rubber Removable Two-Piece Metal Compression Fittings. Acceptable if elongation or tear does not extend beyond outer or inner sealing groove of inner ring or over 1/2 the distance to the next hole.

g. Thread-Damaged Fittings. Acceptable if serviceability is not affected.

7.6.9 Inspection Procedures for Depot Maintenance of time-Phase Scheduled Aircraft at AFMC Depots or Contractor Facilities. Refer to Chapter 9.

7.7 FUEL CELL REPAIRS.

7.7.1 Repair of Installed Cells. If an installed cell is determined to be leaking, repairs may be accomplished while the cell is in the aircraft. Partial removal of the cell may be required for some repairs. A decision to remove the cell or accomplished the repair while the cell remains on the aircraft shall be based on; time required to remove the cell, difficulty of the task, availability of spares, and probability of undetected leaks. The following defects may be repaired while the cell is installed pinholes, inner liner cuts, loose supports or hangars, blisters, loose seams or patches, weather-ozone checking when cords are not damaged, and self-sealing cell activation less than three inches in diameter.

7.7.2 Repair Capability Restrictions.

7.7.2.1 Each activity is encouraged to repair all fuel cells to the fullest extent possible. Repair capability will be based on tools, equipment, facilities, skills, frequency of each repair, and mission requirements.

7.7.2.2 The following repairs are generally best performed at depot or contractor facilities

a. Self-sealing cell repairs.

b. Repair or replacement of hangars or straps.

c. repair or replacement of lacing ferrules.

d. Repair or replacement of fittings.

e. Corner repairs.

f. Extensive weather-ozone checking.

7.7.2.3 The following repairs are usually accomplished at the field level.

a. Pinhole damage.

b. Closed hole or slit type damage.

c. Blister repair.

d. Loose seams or patches.

e. Weather-ozone checking requiring a patch less than 12-inches square.

f. Corrosion treatment.

7.7.2.4 The following conditions warrant condemnation of the cell upon approval from the system manager

a. Self-sealing cell activation in excess of 200 square inches or which extends into a corner or step-off area.

b. Damage in an awkward location making patch roll-down impossible.

c. Weather-ozone checking of the inner liner which exceed 5 percent of the total surface area or which requires a patch larger than 36-inch square or equivalent area.

7.8 REPAIRING BLADDER-TYPE CELLS (EXCEPT GOODYEAR VITHANE).

7.8.1 General. These cells are of lightweight construction composed of one or more plies of rubberized nylon or rayon fabric on the exterior of the cell, a nylon barrier and a ply of rubberized rayon or nylon fabric or Buna-N gum on the interior. When the nylon barrier is suspected of being damaged an inside repair shall be made.

7.8.2 Types of Damages and Repairs.

7.8.2.1 Pinhole Type Damages. A pinhole type damage which penetrates the nylon barrier will require an inside patch. A patch will not be required on the cell retainer unless the cell has been sharply creased in the area of the leak or the retainer cords are damaged.

7.8.2.2 Repairing Weather-Ozone Checked Inner-Liners. Cells with weather-ozone checked inner-liners that do not exceed a maximum of five percent of the total surface of the cell or do not exceed 36 by 36 inches or equivalent for any one patch shall be repaired as per paragraph 7.8.6.c.

7.8.2.3 Blister Damage. A blister is caused by trapped air between the liner and barrier, or between fabric or Buna-N gum and the nylon barrier, or between the layers of nylon in the nylon barrier. Pattern, location, size and leakage are the main factors affecting the cell. Blisters on the bottom and lower sides of the cell are subject to more pressure from the fuel than those in the top and upper sides of the cell. Blisters equivalent to 1/2 square-inch are not detrimental and need not be repaired; however, if two or more are found within a six square-inch area, they shall be repaired as per paragraph 7.8.6.d.

7.8.2.4 Corner Repairs. Pinhole leaks in irregular corners less than 90 degrees shall be repaired with small patches, 1/2-inch in diameter or larger, to facilitate application without wrinkles as per paragraph 7.8.6.h.

7.8.2.5 Inside/Outside Repairs. Cells with Buna liners shall be repaired with Buna-N sandwich material. Cells with fabric liners shall be repaired with nylon sandwich. If nylon sandwich is not available, Buna-N sandwich material may be used.

7.8.3 Materials required. Buna-N sandwich material, Buna Nylon material, emery cloth, solvent (MEK, MIBK, or MIL-C-38736), cement (MIL-A-9117), part No. 1895, or part No. 95195, stiff bristle brush, Buna Vinylite lacquer, clean absorbent lint free cloth, heater, non-waxed pencil, vacuum cleaner, hand roller, airfoam hot patch.

7.8.4 Repair Procedures.

7.8.4.1 Support cells, if required, in the area around the damage so that the edges will be aligned properly in their natural positions see (Figure 7-16).

7.8.4.2 Mark the area two inches in all directions from the damage on the inside of the cell and 2 1/2-inches on the outside with non-waxed pencil.

7.8.4.3 Buffing. Buffing may be done by hand using a medium grit emery cloth or with an air driven power buffer. A 320 grit surface is recommended for the power method. Buffing shall be sufficient to remove all gloss, leaving the surface covered with fine scratches. Buff enough to clean 1/4-inch area around the largest patch to be applied. (See specific repair procedures for patch size.) Care shall be taken when buffing the interior or exterior fabric of cell walls. Buffing through fabric causes additional damage.

7.8.4.4 Patches. Cut a beveled patch from the appropriate repair material to extend 1 1/2-inch from the edge of the damage in all directions for inside repair and two inches from the edge of the damage in all directions for an outside repair. Shears shall be tilted during cutting to achieve the beveled edge. The patch edges shall be a smooth rounded outline. The bottom or contact side shall be buffed in the same manner as the cell. Only one patch is required on the interior flat surface and one on the exterior flat surface of the cell for damages less than three inches in size. Repairs to larger damages require two patches on both the inside and outside of the cell. The edges of the first patch are to be well “feathered” to provide adhesion and to prevent the formation of a channel between the two patches. The second patch shall be one inch larger in all directions than the first.

7.8.4.5 Cleaning. The cell and the patch shall be cleaned with a clean cloth moistened with solvent immediately before cementing. Do not touch the surfaces being cleaned since fingers and hands leave an oil film that will prevent adhesion of the cement.

7.8.4.6 Cementing. Apply cement in accordance with the manufacturer’s instructions. If manufacturer’s instructions are not available; Apply three coats of cement to both the cell and the patch. Allow each coat to dry approximately 30-45 minutes. Apply each coat of cement in a opposite cross pattern. If the cement is allowed to dry for 24 hours, apply two additional coats of cement.

7.8.4.7 Patch Application. Apply in accordance with manufacturer’s instructions or use the following procedure. When the third coat is dry activate the cement, on the cell and patch, by wiping with cheesecloth moistened with solvent. Activation of the cement will make the cement tacky. To determine if the cement is tacky, press a knuckle gently against the surface and withdraw it. Cement should feel tacky without adhering to the knuckle (the knuckle test). When the areas are sufficiently tacky, center the patch over the damage see (Figure 7-18) and roll down firmly with a 1/4-inch hand roller, starting from the center of the patch and working to the outer edges see (Figure 7-19). This will help prevent trapped air or a blistered condition.

7.8.4.8 Care shall be taken not to apply the patch before the cement has reached the proper stage of tackiness. If the cement has reached the proper stage before the patch is applied, there will be no skidding or sliding of the patch immediately after application. Sliding shall not be evident in any area of the patch. If blistering or poor adhesion is found in the patch, it shall be removed. A clean cloth moistened with solvent and rubbed briskly over the cement before the cement is completely dry will remove the patch satisfactorily. After the solvent had dried completely, (approximately one hour) a new patch shall be applied, using three coats of cement applied in accordance with paragraph 7.8.4.6.

7.8.4.9 Repair Inspection. No inspection shall be made on the cold patch repair for 24 hours. After the patch has set for 24 hours, without movement of the cell, check for looseness. Any loose patch shall be removed and reapplied. Seal the edges with two coats of cement after the patch has been accepted as serviceable and allow drying completely.

7.8.4.10 Additional Patches. After the repair inspection is completed on the first patch, the procedure may be repeated as required to apply additional patches. After the final patch is inspected and accepted the cell must cure for an additional 48 hours. The outside patch will be coated with two coats of Buna Vinylite lacquer.

7.8.5 Vulcanizing (Hot Patch) Repair. This method is accomplished by the same method as stated in paragraph 7.8.4, except for the cements used and the curing cycle. The curing cycle is reduced from 72 hours to one hour.

7.8.5.1 Buff the inner-liner enough to clean a 1/4-inch wide area around the largest patch to be applied as described in paragraph 7.8.4.d.

7.8.5.2 After the prepared patch has been rolled down, place 1/4-inch to 1/2-inch thick cloth foam and a 1/8 to 1/4-inch thick aluminum plate over entire surface. Place a plate, as above, on the opposite side of the repair.

7.8.5.3 Apply a heating unit to the plate covering the patch and secure with a C-clamp. Tighten until firm. Do not distort cell.

7.8.5.4 Apply heat for one hour at 290°F +/-10°F surface temperature of heating unit. Allow the unit to cool to room temperature before removing C-clamp and plates.

7.8.5.5 Inspect repaired area for proper adhesions of patch. If loose edges are found, re-cement area and re-cure as stated in paragraph above.

7.8.6 Specific Damage Repairs, Bladder and Self-Sealing Cells (Except Goodyear Vithane).

NOTE

Specific damage repairs will be accomplished per the general procedures in paragraph 7.8. Exceptions to that procedure are stated with the description of the specific damage.

7.8.6.1 Repairing Inside Closed Hole or Slit-Type Damage. (Self-sealing or bladder cells.) A closed hole or slit-type damage that does not extend through the barrier of the cell with no displacement of material, and which is not more than two inches long, shall be repaired as outlined in paragraph 7.8.5. This repair will require only one patch on the inside of the cell. Damages which exceed these limitations will be repaired with patches on both side of the cell.

7.8.6.2 Outside Repairs (Self-Sealing and Bladder Cells) with Damage that Extends only through the Outer Ply.

a. The cell shall be supported around the damage so that the edges of the damage can be properly aligned in their natural positions. Build a trestle or other support inside the cell. Wooden blocks or boards shall be padded or covered with felt or sponge rubber to protect the liner from damage. The procedures outlined in paragraph 7.8.4, shall be followed, except that the patch material will be changed to outside fabric. After inspection apply two coats of Buna Vinylite lacquer on the patch and the buffed area, allowing each coat to dry thoroughly.

b. When repairing a self-sealing cell with a closed hole or split-type damage of over two inches, outline an area three inches in all directions from the damage with a silver pencil.

c. Patch Preparation. Prepare the first patch to extend one inch in all directions from the damage, using the same type of material as that being repaired. This patch shall be buffed and feather-edged on both sides. The second patch shall extend 2 1/2-inches in all directions from the damage and be prepared in the same way as stated in paragraph 7.8.4.

7.8.6.3 Repairing Weather-Ozone Checked Inner-Liners. Fuel cells with weather-ozone checked inner-liners that do not exceed a maximum of five percent of the total surface of the cell or do not exceed 36 by 36 inches or equivalent surface area for any one patch, shall be repaired as follows

a. Mark an area one inch larger in all directions from the checking with a silver pencil.

b. Make a patch of Buna-N sandwich material to extend 1/2-inch in all directions from the checked area; buff the patch and the area. When using a power buffer, buff very lightly to keep the liner from burning and never buff the liner to the barrier. Clean the patch and the area with a clean, lint-free cheesecloth moistened in solvent.

c. Apply three coats of cement to the patch and the area. The first coat shall be applied with a stiff bristle brush, working with a circular motion so the cement will be worked into the checks. Each coat of cement shall dry completely before the next coat is applied. Activate both surfaces with solvent and place the patch in position and roll down. After the cement has dried and been checked for looseness, apply two coats to the outer edge of the patch.

7.8.6.4 Blister Repair. An inner-liner blister is caused by trapped air between the liner and the barrier and is often mistaken for ply separation, which is the loss of adhesion between successive layers. Blisters under 1/2-square-inch are not injurious and need not be repaired; however, if two or more are found within a 6-square-inch area they shall be repaired.

a. To repair a blister, buff its surface and an area extending 2 inches in all directions from its edge. Slit the blister with a knife from end to end and buff the underside of the loose edges by hand. The slit may be cut to resemble two "Ys" placed end to end. Apply three coats of cement, to the inside surfaces, let each coat dry thoroughly.

b. Roll down the blister to remove all trapped air. After the cement has dried thoroughly, apply a patch of Buna nylon sandwich material for a cell with Buna liner; or apply a patch of fabric nylon sandwich material for a bladder cell with a fabric liner extending 1 1/2-inches in all directions from the blister's edges. Complete the repair in the same way as for inside damage.

c. When repairing blister or separation using the hot patch method, clean area with solvent. Apply three coats of hot patch cement (part No. 1895C or part No. 95195) letting each coat dry to the touch before applying the next. When the third coat of cement has dried to the touch, activate the cement with solvent. Roll down the blister to remove all trapped air and install the patch. Apply heating iron.

7.8.6.5 Repairing Loose Seams and Patches Outer Edge. Loose lap seams on the inside of a cell shall be repaired as soon as they are noticed. This will prevent the looseness from spreading to the sealant.

a. Buff an area on top of the loose seal 2 inches in all directions from the edges of the loose seam, continuing the measurement to the cell wall if necessary. Clean the area inside the separation with a lint-free cheesecloth moistened with solvent. Let the area dry and apply three coats of cement, allowing it to dry thoroughly between coats. Wipe the cemented area with lint-free cheesecloth moistened with solvent. This will yield a tacky condition. Firmly roll down the loose seams to remove trapped air and let the seal dry before proceeding.

b. Cut a patch of Buna-N sandwich material or nylon fabric sandwich material to extend 1 1/2-inches in all directions from the edge of the loose seams. Round the corners slightly and bevel the edge of the patch. Buff the patch on the side to be cemented to the cell with the beveled side out. Clean the buffed surface of the patch and cell with solvent, apply the patch and complete the repair in the same way as to an inside injury. Seal edges of patch with 2 coats of cement.

7.8.6.6 Loose Lap Seams. Loose lap seams on the outside of the cell shall be repaired in the same way as described in paragraph 7.8.6.e, except the material comparable to the outside material of the cell shall be used. Loose patches shall be removed and replaced.

7.8.6.7 Repairing Hangar Supports and Straps.

a. Many cells require external or internal support hangers to hold the cell in installed position. Some larger cells have straps on the outside for handling and packing convenience. Most fittings are single flange construction and are not difficult to install. When a damaged hanger, strap or fitting is found it shall be repaired or replaced.

b. Many hangers have metal inserts; to remove a fitting of this type, the fabric shall be cut away around the insert and used as a guide in removing the fitting. Hangers without the metal inserts shall be buffed off or pulled off using solvent. If solvent is used, the repair shall be delayed for one hour to allow the area to dry completely. When buffing the old fitting flange, care shall be taken not to break the fabric on the cell.

c. Buff the contact side of the new fitting. Clean the fitting and an area on the cell which has been buffed 1/2-inch larger than the flange of the new fitting. Apply three coats of cement, allowing each coat to dry completely. Activate both cemented surfaces with lint-free cheesecloth moistened with solvent. When the surface is properly tacky, place a hanger directly over the old hanger location and roll down firmly with a roller.

d. Prepare a cover patch that extends 1-inch beyond the fitting flange. Cut out the center of the patch and allow 1-inch to overlap the fitting flange. Buff the inside of the patch and the area in which it is to be installed. Clean the area and apply three coats of cement to both surfaces, allowing each coat to dry completely. Activate both surfaces; place in position and roll down. After the cement has dried, apply two coats of cement to the entire buffed surface.

e. Repair replacement procedure for the ferrule Teflon cylinders. Remove the excess remaining cement from the nylon strap by any suitable means, taking care not to damage the strap. Use cheesecloth moistened with solvent to clean the area from which the adhesive was removed. Apply a coat of cement to the cleaned surface on the strap.

7.8.6.8 Inside Corner Repairs. All inside corner repairs require a double (two-layer) patch. To prevent wrinkling or stretching the repair material, these patches shall be cone-shaped and shall fit accurately into the corner.

a. Buff the area around the damage for 2 inches in all directions from the edge of the damage in the same way as when repairing a flat surface.

b. Cut a patch of Buna nylon sandwich material large enough to extend 1/2-inch in all directions from the edge of the damage. Cut a single slit in the patch running from the outside edge to the apex of the corner. At the end of the slit in the center of the patch make a second slit 1/8-inch long at a right angle to the first slit (see Figure 7-21).

c. Before any cement is applied, fit the patch carefully into the corner. Trim it to size and place the slit so that the lap will form itself to a flat surface of the cell. Use a silver pencil to lightly mark an outline of the patch on the cell with the patch in place, indicating the location of the slit so that the patch can be returned to the same position after cementing.

d. Patch shall be buffed on both sides and feather-edged before cementing. Buff topside of overlapped patch at the slit, wash and cement.

e. Three coats of cement, shall be applied to the buffed area of the cell and the inside of the patch. When the third coat is completely dry, wipe with a cheesecloth moistened in solvent. When tacky, the patch shall be aligned with the outline previously drawn on the cell. Press down a narrow strip of the patch running from the outer edge of the corner of the slit. Place the patch so that it accurately matches its outline and so that the inner end of the slit actually falls in the apex of the corner.

f. The patch shall be worked down with a hand roller. Start rolling from the edge of the slit which has already been stuck down and work around the patch to the outer edge of the slit. Be extremely careful to avoid any wrinkles or trapped air. If the roller or stitcher is too awkward the patch may be applied with a rolling motion of the finger.

g. After patch has been rolled down, apply three coats of cement to the flat surfaces that form the lap; allow each coat to dry thoroughly before applying the next coat. When the third coat is dry, moisten the area with a cheesecloth moistened with solvent and roll down the lap.

h. Be sure that all edges are rolled down securely. If some do not stick, wipe the loose places with cheesecloth moistened with solvent. If loose edges are found after 2 hours dry time, apply another thin coat of cement. Allow to dry and roll again after it has been remoistened with MIBK or MEK solvent. If the patch is still loose at any place, it shall be removed and scraped, the cell cleaned of cement and the repair restarted.

i. After the first patch has been carefully examined and found to be smooth and tight, apply a second patch in the same manner as the first after it has been fitted to the corner by making a slit and overlapping. The location of the overlap on the second patch shall be opposite that of the first patch (see Figure 7-21).

7.8.6.9 Outside Corner Repairs. Outside corner repairs are made in approximately the same manner as inside corner repairs. Patches are cut from outside repair material similar to the outer ply construction and are applied by the same method as outside patches for slit-type injuries on a flat surface. The lap on the outside corner patch shall be covered by an extra strip of repair fabric extending 1/2-inch on each side of the outside edge of the lap from the apex of the corner to the outer edge of the patch.

7.8.6.10 Exposed Fabric Repairs. Exposed fabric outside and inside of fuel cells will be repaired using procedures outlined in paragraph 7.8.5 or 7.20.

7.9 SELF-SEALING CELL REPAIR.

7.9.1 General. Repairing separations of over 3 square inches. Sealant separation or swelling is caused by fuel coming in contact with the sealant, and can be caused in one of two ways. A pinhole or cut through the nylon barrier or spillage of fuel to the outside of the cell, which will wick to the sealant, causing swelling or separation, and will sometimes split or rupture the inner liner. The separation shall be trimmed and care shall be taken not to damage any plies. After all damaged plies have been removed, trim 2 inches beyond to make sure that all fabric that might be fuel soaked is removed, then the area shall be checked. If the damaged area is over 200 square inches or extends into a corner or step off area, the question of whether to repair or condemn a cell will depend upon the availability of spare cells, cost involved, or extensive damage to the cell which would make repairs extremely difficult or in some cases impractical.

7.9.2 Inside Preparation.

7.9.2.1 After the damaged area has dried for 72 hours, the plies shall be trimmed to allow a 2-inch step or lap of each ply. If all plies were damaged and removed, the repair shall start by applying a patch to the outside. This path shall be of fabric material of the same weight in which the cell was manufactured, and shall be large enough to extend 4 inches in all directions from the edge of the cutaway section. Center the patch over the section and using a silver pencil, outline an area 1/2-inch larger in all directions than the outside edge of the patch, buff the patch and the outlined area on the cell, and clean the area and the patch with cheesecloth moistened in solvent.

7.9.2.2 Apply three coats of cement to the area and the patch, and allow each coat to dry thoroughly.

7.9.2.3 Before the patch is applied, wipe with cheesecloth moistened in solvent. Make the knuckle test to determine if the cement is tacky.

7.9.2.4 When the cemented areas are tacky, the patch shall be centered within the silver lines and rolled down firmly with a 1/4-inch hand roller, starting at the center of the injury and rolling outwards. This will require two repairers on a large cell as one repairer must enter the cell and back the area being rolled with a sheet of plywood or other solid backing. All sharp corners or edges shall be removed from the backing platform.

7.9.2.5 After the outside patch has dried for 24 hours, the rest of the repair shall be made from inside the cell. Make a patch of repair fabric to fit the first inside step area of the repair and buff both sides. Apply three coats of cement, to one side of the patch and to the inside of the cell; when the last coat of cement is dry, wipe with cheesecloth moistened in solvent. When tacky, install the patch by holding the two edges together, centering the patch, and rolling it into place, starting in the center and rolling outward.

7.9.2.6 After the fabric ply has been installed and carefully checked to make sure that there is no trapped air, cut the next ply of gum sealant to fit as close as possible to the area in which it is to be applied. Remove gloss from both sides of the uncured sealant by using 120-grit sandpaper by hand. Care shall be taken in cleaning the sealant and only a minimum amount of solvent shall be used. Solvent will cause the sealant to swell. Apply three coats of cement to both the sealant and the area in which it is to be applied. Care shall also be taken in rolling this ply into place, because the sealant will cut easily under the pressure of the rollers.

7.9.2.7 The next ply is cut from outside fabric repair material. Buff both sides and clean. Apply three coats of cement and roll down in position after the cement has reached its proper tackiness. The next ply shall be of sealant gum and shall be prepared and applied in the same way as the first ply of sealant gum.

7.9.2.8 After the second ply of sealant gum has been applied, it should bring the repair up to the level of the outer ply. If additional thickness is needed to obtain this required level, sealant gum, 0.055-inch gage or 0.110-inch gage, shall be used to obtain the required level.

7.9.2.9 After the required level has been reached prepare a patch of Buna nylon sandwich material, cured on both sides. The patch shall be cut large enough to extend two inches in all directions beyond the cut-away area. This patch shall be buffed and feather-edged on both sides to prevent air entrapment at step-off area when the cover patch is applied. After the patch is buffed and cleaned, apply three coats of cement to the cell and patch and allow to dry to knuckle-test consistency. Activate the cement with solvent. Center the patch on the repair, and roll down.

7.9.2.10 When the nylon sandwich patch has been completely installed, no air bubbles are found, and all edges are rolled down, prepare a cover patch from Buna nylon sandwich material. The patch should extend 3 inches beyond the first inside patch. Buff the inside of the patch and bevel the patch on the outside edge, apply three coats of cement to both the patch and the damage area. Allow both areas to dry to knuckle-test consistency. Activate the cement with solvent, roll down the patch, and apply two coats of cement around the edges of the patch.

7.9.2.11 The cell shall be kept in the position in which it was repaired for 24 hours before any flexing is allowed. Repair then may be flexed normally to permit inspection for air bubbles.

7.9.3 Separation that Extends into Fitting Area. A separation that extends into and under a fitting flange shall be repaired in the same way as an inside preparation with the following exceptions

7.9.3.1 Line the fitting with a fine line of silver pencil, making the lines long enough to extend beyond the repair area, and cut out the fitting.

7.9.3.2 When installing an outside cover patch, the patch shall be cut in a shape and size large enough to extend completely around and three inches in all directions from the throat of the fitting.

7.9.3.3 After the repair has been completed install the fitting.

7.9.4 Repairing Hole-Type Damage Less than Three Inches in Diameter Build-up Repair.

7.9.4.1 Mark two circles around the damage on the outside of the cell wall with a silver pencil. Draw the inside circle large enough to include all damaged sealant and ragged edges, but not smaller than three inches in diameter; draw the outer circle on a one inch larger radius (see Figure 7-23). Buff an area on the cell extending from the outside circle outward for a 2 1/2-inches larger radius and remark the outside circle. Using the inside circle as a guide, cut away the cell material with a knife blade held at a right angle to the cell wall. Then bevel-cut the edge of the hole, using the larger circle as one guide and the edge of the liner in the hole as another. This results in a shallow bevel of about 30 degrees, and provides an efficient adhesion surface.

7.9.4.2 Buff the inner liner for 4 1/2-inches away from the edge of the hole. Make a patch of Buna nylon sandwich material three inches larger than the diameter of the hole. Make a second patch of repair Buna material to overlap the first patch 1 1/2-inches. Featheredge the first patch and buff both sides. Apply cement to the inner liner of the cell and with MIBK or MEK solvent. When proper tackiness is obtained, center the patch over the hole and roll obtained, center the patch over the hole and roll down. Buff the down side of the second patch and, when the first patch is dry, apply three coats of cement to the areas and the patch. When the cement is properly tacky, center the patch and roll down. When the cement is dry, check for air bubbles and apply two coats of cement to the edges of the patch.

7.9.4.3 Build a trestle or other support inside the cell under the area to be repaired. Wooden blocks and boards used inside cells shall be padded or covered with felt or sponge rubber to protect the liner from damage (see Figure 7-16).

7.9.5 Laying and Rolling Sealant. Cut as many patches of sealant as there are layers of sealant in the injured area one inch larger in diameter than the diameter of the cutout in the cell. Use sealant material comparable in thickness to the material in the area of the damage. As layers are applied, coat each surface with three coats of cement, on both sides of the sealant for adhesion, and let them dry to knuckle test consistency. Apply each layer separately rolling down thoroughly. Care shall be taken not to cut the sealant with the roller. After the repair has dried carefully trim the excess sealant to a line flush with the outside of the cell (see Figure 7-24) and Figure 7-25). A handy tool for fuel work can be made from an ordinary soldering iron. Braze a semicircular piece of copper approximately 3/8-inch thick and cut on a 1-inch radius onto a 3-1/12-inch length of 3/8-inch round copper stock. Taper the head down so that the tool resembles a rod cutter. Refer to Chapter 8 for fabrication instructions. Insert the finished part into the soldering iron in place of the regular copper tip. This is known as a “hot knife” and is adaptable to removing fittings, trimming sealant, etc. It cuts very easily when hot and care shall be taken not to cut too deeply. Workmen shall practice on a condemned cell before using the knife for actual repair. Apply an outside retainer or cover patch the same as that outlined in paragraph 7.9.4.a and 7-9.4.b, except that outside material fabric shall be used.

7.9.6 Reinforcing Wrap for Tubular Fitting.

7.9.6.1 In order to strengthen fittings and retard normal ozone cracking of synthetic rubber, all tubular or barrel type fittings shall be wrapped with outside repair material. Light gage fabric material shall be used to provide flexibility. The procedures for wrapping fittings will vary with the type of fittings involved, although the principle is the same. Wraps for two-piece fittings i.e., a fitting in which the tubular or protruding barrel is molded separately and is detachable from the flanges vulcanized to the wall of the cell will extend only the length of the tubular portion and will terminate 3/8-inch from the base of the tube (see Figure 7-26). The normal procedures for wrapping fittings are

7.9.6.2 Determine the extent to which the fitting surface is to be wrapped. This shall include as much of the tubular portion as possible and, in one-piece fittings, the fingers shall extend two inches onto the flat surface of the cell (see Figure 7-27).

7.9.6.3 Wrap the fitting with paper to make an exact template of the required stock. Allow enough stock to get to good butt point.

7.9.6.4 Cut the patch from outside repair fabric, using template as guide, which has been buffed on the down side. The template may be saved and used on other fittings of the same manufacturer and stock number.

7.9.6.5 Remove any partial fabric wrapping which may have been previously applied to the fittings.

7.9.6.6 Buff the surface on the fitting by hand with 80 to 120-grit sandpaper. Do not use a power buffer. Fittings are easily damaged and are difficult to replace.

7.9.6.7 Apply three coats of cement to the fitting surface and patch. Allow each coat to dry completely.

7.9.6.8 Buff and cement the fabric wrap in the same way as when preparing an outside patch.

7.9.6.9 Apply the fabric wrap carefully to the fitting, rolling down securely and butting at adjoining surfaces. A mandrill the same size as the inside diameter of the tubular fitting, sometimes may be inserted to facilitate rolling.

7.9.6.10 After one-piece fittings have been wrapped, the fingered area shall be covered with a reinforcing patch. Cut the cover patch so that its inside diameter is the same as the outside diameter of the base of the fitting and so that the outside diameter of the cover patch extends 1/2-inch beyond the fingers of the wrap.

7.10 REPAIR OF BURRS, SCRATCHES, NICKS OR OTHER DAMAGE ON THE SEALING SURFACE. INCLUDING O-RING GROOVE.

7.10.1 Lightly sand the damaged area with 600 grit emery cloth. Extend the sanded area no more than two inches beyond either side of the damage. A tongue depressor may be used to assist sanding.

7.10.2 Clean the fitting with solvent.

7.10.3 Apply chromate conversion coating, MIL-C-81706, in accordance with T.O. 1-1-691.

7.11 FITTING REPLACEMENT ON NONMETALLIC CELLS.

7.11.1 Fitting replacement on nonmetallic cells are made in the same way as fitting replacement on self-sealing cells. Fittings for different nonmetallic cells are interchangeable to a limited extent; fittings may be interchanged in cells which have similar construction and which are equipped with fittings with the same distance between flanges.

7.12 FACILITY REQUIREMENTS.

Repair of fuel cells shall be accomplished in a warm, dry place. The temperature should be controlled to maintain 60°F to 75°F. The procedures stated in this paragraph should be followed in sequence to insure that all defects are identified prior to starting repair. Failure to follow this sequence may result in wasted man-hours and materials on cell which must be condemned or transferred to depot level repair activities.

7.13 SELF-SEALING CELL DRYING.

Self-sealing cells shall be drained and dried thoroughly as soon as possible after the damage is found to prevent excessive swelling of the sealant. Drying may be speeded by placing the cells in a warm (75°F) location, and using a flow of air through the inside of the cells. Higher temperatures will dry out the fuel-soaked sealant next to the injury and will trap fuel in the sealant. The trapped fuel will cause separation and breakdown in the sealant area at a later date. To prevent this condition, the edge of the damage shall be spread slightly with wooden pegs to allow fuel and fuel vapors to escape from the sealant. This type of damage requires several days to dry.

7.14 CLEANING BEFORE INSPECTION.

The fuel cells shall be cleaned as required with clean, lint-free cloth, moistened with cleaning solvent (P-D-680, Type II) before any inspection is made. Liquid soap, (P-S-560) and hot water (not to exceed 120°F) may be used for large-scale cleaning. All soap residue shall be removed with clear water and the cells shall be dried thoroughly after cleaning.

7.15 MARKING DEFECTS AND AREAS TO BE REPAIRED.

When marking damaged areas or making alignment marks for fittings or patches, all marks will be made with non-waxed silver, white or yellow pencil.

7.16 TESTING.

Removed cells should be tested if possible to locate all leaks and make a determination of repair feasibility.

7.17 INSPECTION.

All cells shall be inspected prior to beginning repairs.

7.18 REPAIR CAPABILITY AND RESTRICTIONS.

Determination of repair capability will be based on tools, equipment, facilities, skills and frequency of each type of repair at the level of maintenance. Consult the applicable -6 technical order for specific repair restrictions.

7.18.1 The following should generally be considered as field level repairs

a. Pin hole damages.

b. Closed hole or slit type damages.

c. Blister repairs.

d. Loose seams or patches.

e. Self-sealing cell hole damages less than three inches in diameter.

7.18.2 The following repairs should generally be considered as depot or contractor level repairs

a. Repair or replacement of hanger or straps.

b. Repair or replacement of lacing ferrules.

c. Repair or replacement of fitting.

d. Corner repairs.

e. Extensive weather-ozone checking.

f. Self-sealing cell repair.

g. Cells with damage exceeding the following limitations should be condemned upon approval of the system manager.

h. Self-sealing cell sealant activation which exceeds 200 square inches or extends into a corner or step off area.

i. Injury in awkward locations making a patch impossible to roll down.

7.19 REPAIRING GOODYEAR (VITHANE) CELLS.

7.19.1 General.

7.19.2 Vithane Fuel Cells differ in construction and material from nitrile Buna-N-Rubber Fuel Cells and can be identified by the Goodyear constructive numbers BTC-54A, 67, 49, 69, 85, 86, 101 and number variations such as 86-1. Repair shall be made by entirely different methods and materials. Vithane fuel cell ZF16 37764 incorporates a self-sealing panel on left and right sides of cell. Vithane construction consists of one or more plies of urethane spray, coated nylon or polyester fabric, a fuel barrier, and a urethane sprayed inner-liner. Buna-N rubber shall not be used for these repairs.

7.19.3 Types of Damages and Repairs.

7.19.3.1 Separations. Remove all loose material. Apply both an outside and inside repair patch.

7.19.3.2 Holes, punctures, cuts, tears or abraded area. Trim away all loose or ragged material and apply an outside and inside repair patch.

7.19.3.3 Loose edges or loose fitting flanges. Abrade the area with emery cloth. Clean with solvent and apply two coats of cement to each contact surface. Clamp and cure.

7.19.3.4 Missing coat. Abrade surface adjacent to the missing coat with emery cloth. Clean with solvent and apply four coats of cement and cure.

7.19.3.5 Sealing surface-metal. For repair of metal sealing surface, see below.

7.19.3.6 Accessory replacement. Abrade the contact surface smooth when adding or replacing accessories.

7.19.3.7 Activated area. Mark out a 3-inch, 4-inch, or 6-inch circle, one that includes all the activated sealant. Cut out material to the marked line, making sure that the cut is made in sound non-activated material. Apply the self-sealing repair plug.

7.19.4 Repair Limitations.

7.19.4.1 Inside patches are to overlap the damaged area a minimum of 1-inch in each direction.

7.19.4.2 Outside patches, when required, shall be 1/2-inch larger than the inside patch.

7.19.4.3 Separations between layers (or plies) larger than 1/2-inch diameter require repairs.

7.19.4.4 Slits, tears, and activation are limited to 6-inches maximum length, or diameter.

7.19.4.5 Loose edges may be trimmed, provided a 1-inch minimum lap or seam is maintained.

7.19.4.6 The maximum number of heat applications permitted on the same repair is limited to four.

7.19.5 Repair for Non-Self-Sealing Goodyear (Vithane) Cell.

7.19.5.1 Trim all loose or damaged fabric from the repair area with scissors. The damaged area shall be rounded to prevent further tearing of the cell.

7.19.5.2 Clean and tape cell surface with solvent approximately 12 inches beyond the damaged area.

7.19.5.3 Inside patch. Cut the patch from repair material (FT-227) large enough to cover the damaged area, and extend a minimum of 1-inch from edge of damaged area in all direction, and round the corners of the patch. If outside patch is required, it shall be 1/2-inch larger than the inside patch.

7.19.5.4 Center the repair patch over the defect. Mark 1/2-inch beyond in all directions.

7.19.5.5 Abrade the cell surface surrounding the damaged (marked) area and the contact side of the patch with fine emery cloth to remove the gloss.

7.19.5.6 Clean the abraded area twice with a clean cloth that has been moistened with solvent.

7.19.5.7 Tape an 8 by 8 inch piece of release film over the defect on the outside of the cell.

7.19.5.8 Cement Mixing and Application.

a. Mix three-part cement (5923C) in accordance with manufacturer's instructions.

b. Brush one even coat of repair cement on the abraded area of the cell to within 1/4-inch of edge and on the abraded side of the repair patch. Allow to dry 15 minutes.

c. Apply a second coat of cement to repair as above. Allow the cement to dry five minutes.

d. Patch Application. Center the inside patch over the damaged area. Lay the repair patch carefully by rolling action from center to edge to prevent trapping air. The repair patch may be moved by hand on wet surface by sliding to center over damaged area. Tape a piece of release film over the patch.

e. Pressure Plates. Cover smooth surface of each of the two aluminum plates (plates must be larger than the cemented area) with fabric backed foam. Tape foam side to the plate. Foam must cover edges of plate for added protection.

f. Sandwich the cell between the padded pressure plates.

g. Apply a 240°F cure iron to the plate covering the repair patch. Secure the assembly with a "C" clamp. Tighten by hand. Wipe off excess cement that flows beyond the pressure plates.

h. Plug the 240°F cure iron into the specified voltage electrical outlet. After two hours cure, unplug the electric repair iron and allow to cool to room temperature. Then remove the heating iron and plates. Remove the release film.

i. Inspect edges of the patch for a complete seal. If loose edges are evident, re-cement patch area and recure as above.

7.19.5.9 Outside Patch Application. Use the same procedure as described for inside patch repair. Outside shall be 1/2-inch larger than the inside patch.

7.19.5.10 Air Cure Method. Follow the same procedures as the heat cure method except omit using the electric cure iron. Air cure each repair for a minimum of 72 hours, undisturbed, at 75°F.

7.19.5.11 Inspection. Vithane cells are to be tested the same as bladder type fuel cells.

7.19.6 Quick Repair of Urethane (Goodyear Vithane) Non-Self-Sealing Fuel Cells.

7.19.6.1 General. This quick repair method is intended for repairing Vithane bladder (non-self-sealing) cells with minor damage without removing them from their cavities. The larger cells, Goodyear Vithane constructions BTC-49, 69, 69-1 and 86, can accommodate the repair without removal. The repair should not be attempted on smaller constructions such as Goodyear Vithane construction BTC-39 and 39-1.

7.19.6.2 Repair Limitations. Repairable defects applicable to quick repair are:

a. Holes, punctures, and cuts - 1/2-inch maximum in any direction.

b. Tears - 1-inch maximum.

c. Abraded areas or missing coating --2-inches diameter provided fabric is not damaged.

d. Loose edges -- trim looseness provided 1/2-inch lap is maintained.

7.19.6.3 Surface Preparation.

a. Cut fabric patch from fabric (3604N). Size the patch to extend 1-inch beyond the damage in all directions.

b. Wash the cell to twelve inches beyond the damage in all directions with solvent.

c. Center the patch over the defect. Mark the cell 1 1/2-inch beyond the parameter of the patch.

d. Abrade the marked cell area with fine emery cloth to remove the gloss.

e. Wash the abraded area twice with a clean cloth using clean solvent.

7.19.6.4 Patch Application.

a. Mix the 82C32 cement. Mix the cement in accordance with the manufacturer's instructions or the following. Pour part No. 2 into the container of part No. 1 and stir with a tongue depressor stick approximately five minutes. Stir thoroughly making sure all part No. 1 cement in the corners of the can is mixed with the part No. 2 cement. Pot life is approximately 15 minutes.

b. Apply one brush coat of 82C32 to the clean abraded area. Let dry 15 minutes. It is best to mix fresh cement for each coat. Apply second brush coat of 82C32. Let dry 15 minutes. Apply third coat of 82C32 cement.

c. While the third coat of 82C32 cement is still wet, lay the 3604N fabric patch in the wet cement and smooth out with a brush, removing all entrapped air.

d. Apply a final coat of 82C32 cement onto the 3604N fabric patch. Allow the repair to air cure for a minimum of six hours at a minimum temperature of 70°F before exposing repair to fuel.

7.19.6.5 Inspection of Repair.

a. Check repair after it has air cured for the specified time to assure cement is cured. Stickiness is an indication of undercure.

b. Check edges of repair for looseness. Looseness up to 1/8-inch may be trimmed off.

7.19.7 Repairing Goodyear Vithane Self-Sealing Cells.

7.19.7.1 General. The self-sealing portion of Goodyear Vithane fuel cells (Goodyear FTL-102), consists of an outer wall of nylon fabric reinforcing plies, sealant material, barrier material, and a Vithane rubber inner liner. The self-sealing is constructed the same as the non self-sealing cells, except that sealant material FT-235 shall be used for repairs.

7.19.7.2 Type of Damages and Repairs. For damages and repairs, refer to paragraph 7.20.

7.19.7.3 Repair Limitations. For repair limitations, refer to paragraph 7.20.

7.19.7.4 Repair of Self-sealing Goodyear (Vithane) Cells. Self-sealing fabric shall be repaired the same as Goodyear Urethane Vithane non-self-sealing fuel cells, except that fabric repair material FT235 shall be used. Refer to paragraph 7.20.

7.19.7.5 Preparation.

a. Trim or cut away all defective material. The opening diameter should correspond to the diameter of the self-sealing repair plug (FT236).

b. Clean inside and outside cell surface with solvent and tape approximately 12 inches beyond the damaged area.

c. Abrade cell surface surrounding the damage 1/4-inch beyond the repair plug flange both inside and outside, and the contact surfaces of the repair plug. Use fine emery cloth to remove gloss.

d. Clean abraded surfaces of cell and repair plug three times with a clean cloth, moistened with solvent. Use clean cloth for each operation.

7.19.7.6 Cement Mixing. Pour two-part 80C29 into container and mix thoroughly. May be used immediately.

7.19.7.7 Plug Insertion and Cement Application.

a. Insert self-sealing repair plug FT-205 in cell with the stenciled side facing out. Push one flange of the plug through the hole and straighten the flanges so they lay flat on both the inside and outside of the repair area.

b. Brush one coat of cement evenly on to the abraded contacting surfaces of the cell and the abraded flanges of the repair plug. Allow to dry for 15 minutes.

c. Apply a second coat of repair cement and allow to dry for five minutes.

d. Lay the plug flanges (one at a time), working out all trapped air to assure good contact.

e. Tape a piece of release film over each repair plug flange.

7.19.7.8 Pressure Plates and Cure.

a. Application and use of pressure plates and heat iron are the same as Goodyear Vithane non-self-sealing fuel cell. Refer to paragraph 7.20.

b. Air Cure. Air cure method is the same as Goodyear Vithane non-self-sealing fuel cell. Refer to paragraph 7.20.

7.19.7.9 Fitting Repair. Replace fuel cell fitting in accordance with instructions contained in paragraph 7.10.

7.19.7.10 Self-Sealed Test. Vithane self-sealing fuel cell shall be leak-tested the same as bladder type fuel cell.

7.19.7.11 Cell Studs. For cell studs on Vithane self-sealing refer to TO 1F-15A-2-12.

7.20 CELLS REPAIRED BY AN APPROVED CONTRACTOR.

All repairs shall be in accordance with this T.O. and other contractual requirements. Repairs shall only be accomplished by approved sources. Replacement cells, other than those obtained from government stock, shall be obtained from a source approved by the contracting officer. When depot maintenance is performed by private industry the contractor representatives shall indicate in writing the qualified source of the cell repair.

7.21 FUEL CELL TESTING.

7.21.1 Fuel Cell Fittings.

7.21.1.1 All cells that have had the fitting sealing or o-ring surface repaired shall be tested after the repair is complete.

7.21.1.2 Materials Required. Plate, air source, manometer, hardware, detergent, water, emery paper, support fixture.

7.21.1.3 Procedures.

a. Clean fitting and plate to ensure no foreign matter is present.

b. Cover each fitting with a plate which has the same bolt pattern as the fitting.

c. Install bolts and torque as specified in the aircraft technical manuals.

d. One fitting shall be equipped with two connectors, one attached to the water manometer and the other to the air supply.

e. Support the cell in a suitable fixture or jig.

f. Inflate the cell to 0.75 psi. If external supports are not available inflate the cell to 0.25 psi maximum and use chemical test (paragraph 7.21.4).

g. Mix a solution of one cup detergent and one gallon of water. Apply to edge of plate.

h. Check for bubbles.

i. If bubbles are noted, release pressure, remove plate, repeat test.

j. If bubbles are still noted; release pressure, remove plate, lightly sand or replace fitting.

7.21.2 Self-Sealing Cells. Test in accordance with instructions provided by aircraft systems manager. In general the test should include a stand test for 24 hours, followed by draining and an internal inspection for sealant activation. Test methods for bladder cells may indicate a no leak condition but may not detect defects which will cause activation of the self-sealing fabric.

7.21.3 Bladder Cells. Test bladder cells by using one or both of the following test procedures after repairs. Test requiring internal pressures may result in an indication of a false leak. Cells found to produce this type of leak from seepage shall be pressurized to 1/4 to 1/2 psi, according to the table below and remain pressurized for up to 24 hours (generally 6 hours is sufficient). A fixture or jig is not required to support the cell for this test.

Table 7-1. Cell Test Pressure

Capacity	Air Pressure	Water Manometer
0 - 1000 GALLONS	1/2 PSI	14 INCHES
1000 GALLONS AND UP	1/4 PSI	7 INCHES
ALL VITHANE CELLS	1/4 PSI	7 INCHES

7.21.4 Chemical Test.

7.21.4.1 Materials required. Silver pencil, plate, air source, hardware, ammonium hydroxide, absorbent cloth, white cloth (cheese cloth or bed sheet), 100cc measure, 200cc measure, 2-quart measure, 15 gram measure, gaseous ammonium, water, phenolphthalein crystals, alcohol, solvent (MEK, MIBK, or MIL-C-38736).

7.21.4.2 Procedures.

a. Air purge the cell for three days or as required to fully evaporate JP8 or any oily residue.

b. Remove all red colored marks from cell. Red marks may give false indication of a leak.

c. Locally fabricate a plate with two inlet fittings to fit any one of the fittings in the cell; one for the air inlet and the other for the water manometer. As an alternate fabricate a plate with three inlet fittings, two for air inlets and the third for the water manometer.

d. Attach cover plates to all openings except the access door. Torque to value specified in the aircraft system manuals.

e. Install the inlet fitting and tighten the cover.

f. Pour ammonium hydroxide on absorbent cloth (100cc for tanks less than 1000 gallons, 200cc for all other capacity tanks). As an alternate method use gaseous ammonium without the absorbent cloth. Develop local procedures to meter the gas.

g. Place cloth in tank.

h. Install access door cover plate and inflate cell (refer to Table 7-1). Maintain 18-24 hours before testing.

i. Prepare leak detection mixture. Mix 15 grams phenolphthalein crystals into two quarts of water, then add two quarts of alcohol.

j. Soak a large white cloth in solution, wring out excess solution thoroughly.

k. Spread cloth over cell and smooth down to ensure detection of minute leaks. Leave cloth in place for a minimum of five minutes.

l. Check for red spots. Due to a chemical reaction the moistened cloth will develop red spots when in contact with the ammonium. Red spots can be removed by resoaking the cloth.

m. Mark leaks as necessary. Repeat steps i through l each time the cloth is moved.

n. Move cloth and repeat procedure to check entire surface.

o. The solution and test cloth remain usable as long as they remain clean. Store excess solution in a closed container to prevent evaporation and deterioration.

p. Remove all cover plates, equipment. Clean all metal surfaces with solvent to prevent corrosion. Do not enter cell until a proper purge has been established.

7.21.5 Soap Suds Test.

7.21.5.1 Materials required. Water, soap (7930-00-282-9699), cover plates, air source, air inlet fitting, silver pencil.

7.21.5.2 Procedures.

a. Locally fabricate an air inlet fitting to fit any fitting on cell.

b. Attach cover plates and air inlet fitting. Torque to value specified in the aircraft system manuals.

c. Inflate cell to proper pressure.

d. Mix one cup of soap and one gallon of warm water.

e. Apply solution to repaired areas or areas suspected of leaking. Checked for bubbles.

f. Mark all leaks.

g. Remove all cover plates, equipment. Wash soap residue from cell and dry. Do not enter cell until a proper purge has been established.

7.22 LACQUER FINISH COAT.

7.22.1 An exterior lacquer finish coat is optional except when specified by aircraft systems managers or specific manuals.

7.22.2 Material Required. Buna Vinylite lacquer, brush, lacquer solvent.

7.22.3 Procedures.

7.22.3.1 Clean and dry (refer to paragraph 7.6.3) all surfaces to be coated.

7.22.3.2 Moderately thin lacquer if necessary.

7.22.3.3 Apply one coat by brush and allow to dry. Do not apply lacquer to fittings.

7.23 FUEL CELL INSTALLATION.

7.23.1 All fuel cells shall be inspected and tested prior to installation. When cells are repaired or replaced in an aircraft, the cell part number, location in the aircraft, and date of installation shall be recorded on the applicable AFTO Form 95.

7.23.2 Materials required. Solvent (MEK, MIBK, MIL-C-38736), absorbent lint-free cloth, non-metallic scraper, cement, lacing cord, alcohol lamp.

7.23.3 Preparing Fuel Cell Cavity for Cell Installation.

7.23.3.1 Inspect all cell fitting mating surfaces and connections for cracks, scratches, distortions, dirt, paint, grease or other damage which could cause a leak. Clean with solvent and scraper, repair or replace as necessary.

7.23.3.2 Inspect backing boards for cracks, chipping, crazing, or other damage which might damage the fuel cell. Replace backing boards as necessary.

7.23.3.3 Inspect cell attaching points for damage or missing hardware. Repair or replace as necessary.

7.23.3.4 Assure all vent or interconnect lines are in there proper positions and hose clamps are in position and accessible.

7.23.3.5 Inspect cavity for nicks, burrs, sharp edges, etc., which could damage the cell. Smooth areas in accordance with the aircraft systems technical manual.

7.23.3.6 Inspect cavity for corrosion. Treat corrosion in accordance with TO 1-1-691.

7.23.3.7 Remove all dirt, grease and other foreign matter from cell cavity.

7.23.4 Uncrating Fuel Cells. Self-sealing cells are shipped in the normal positions. Four-sided or band-type cells are collapsed flat and folded over. Bladder cells are collapsed and folded into small packages. Open all crates in accordance with instruction on container. Open container in a clean area with a smooth surface.

7.23.5 Cell Preparation and O-Ring Installation.

7.23.5.1 Unfold cell. Ensure temperature is above 45 F.

7.23.5.2 Obtain O-rings, ensure compliance with time standards in AFMAN 23-110, PART 3. New O-rings shall be used whenever possible.

7.23.5.3 Inspect O-ring groove on fitting for damage or foreign material.

7.23.5.4 Clean O-ring groove with solvent.

7.23.5.5 Inspect O-ring for nicks, cuts or other damage.

7.23.5.6 Install O-Ring. If O-Ring will not stay in place apply a small amount of petrolatum to the lower surface of the O-Ring groove and O-Ring.

7.23.5.7 Remove all tags, stickers, tapes, protective devices from cell.

7.23.5.8 Ensure fittings are clean.

7.23.5.9 Fold cell.

7.23.6 Cell Installation.

7.23.6.1 Ease cell into cavity.

7.23.6.2 Attach cell to aircraft structure in accordance with aircraft system technical manual. Vithane cells stored for extended periods or dry, low humidity will shrink in overall size. This condition will make the cell hard to install due to misalignment of cell fittings with mating surfaces. If this occurs the cell can be restored by soaking in warm water (120°F) for from two to four hours (longer if necessary). As an alternate to the water soak, if difficulty is encountered during installation, cloths soaked in warm water should be placed on exposed, interior portions of the cell. Wet cloths as often as necessary.

7.23.6.3 Align cell fittings and interconnects. On fittings which use O-rings seat the O-ring so as not to pinch it between the fitting surfaces. Some fittings require the use of clamping rings to hold the fitting together and the O-ring in its groove (refer to aircraft systems technical manuals).

7.23.6.4 Install proper hardware and torque to value specified in aircraft systems technical manual.

7.23.7 Lacing Cords and Knots. Many cells use lacing cords to secure cells to stiffeners, fuel lines, and components in place. Figure 7-33, illustrates the proper method for preparing the ends of the lacing cord. Figure 7-34, illustrated the proper method for tying knots in the lacing cords.

7.23.8 Cell Closing.

7.23.8.1 Clean entire interior surface using sponge or cheesecloth moistened in water. Ensure all lint and other foreign matter is removed.

7.23.8.2 Inspect cell interior for damage.

7.23.8.3 Install cell opening cover and torque bolts to value specified in aircraft systems technical manual.

7.23.8.4 Install cell cavity closure and torque bolts to value specified in aircraft systems technical manual.

7.23.9 Cell Fitting Torque Procedures.

7.23.9.1 To prevent damage to the cell fittings and adjacent structures ensure only bolts of the proper length are used. Torque bolts to the value specified in the aircraft systems manual. Bolt torque patterns are as shown in Figure 7-32. Once a torque pattern is established the same pattern must be adhered to.

7.23.9.2 Molded rubber fittings commonly used for self-sealing cells. These fittings use “cold flow” pressure rubber is force from a high pressure area to a low pressure area. Final tightening is accomplished two hours after initial torque is applied.

7.23.9.3 Compression fittings are commonly used in die-cut cells. Screws used to secure the aluminum halves of the fitting are usually torqued to 10 inch-pounds.

7.24 FUEL CELL DOCUMENTATION.

7.24.1 All fuel cells shall be inspected and tested prior to installation. When cells are replaced in an aircraft the cell location/position, date of installation, serial number, part number, manufacturer's name and date of manufacture shall be recorded on applicable AFTO Form 95.

7.24.2 When fuel cells are repaired prior to installation, the repair source and date of repair shall be recorded on the AFTO Form 95. This AFTO Form shall be maintained in the shop historical files until the cell is removed from the aircraft, at which time the form will accompany the cell.

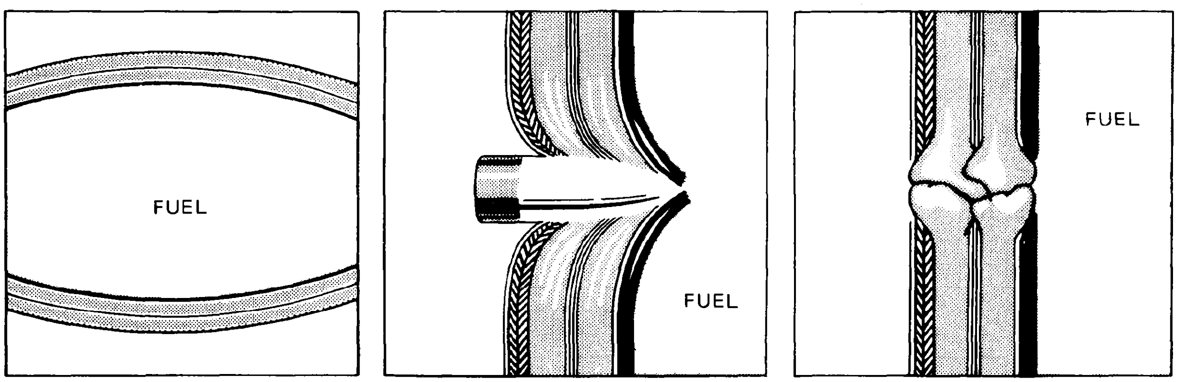


Figure 7-1. Projectile Sealing Action

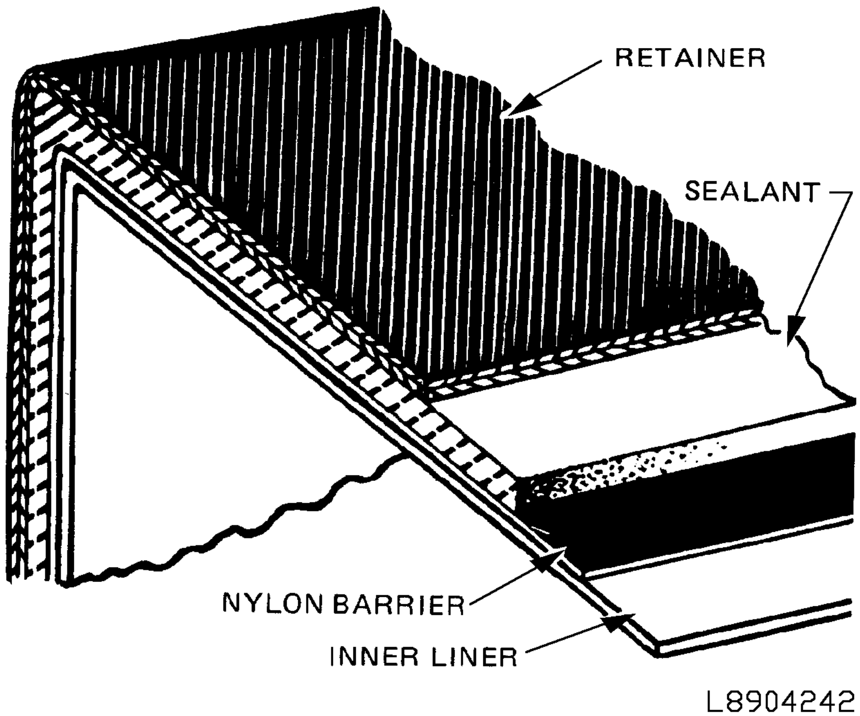
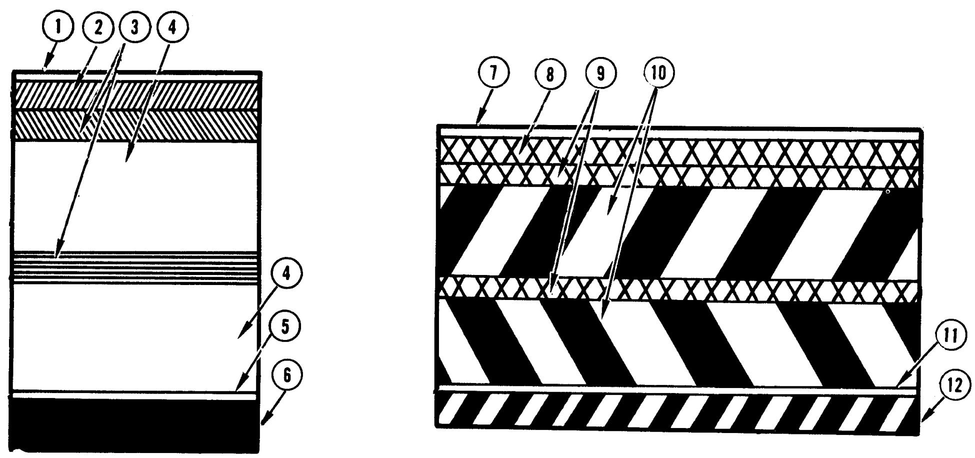


Figure 7-2. Fuel Cell Chapter



1 BUNA VINYLITE LACQUER
2 NYLON FABRIC
OUTSIDE SKIM: BUNA
INSIDE SKIM: RUBBER
3 CORD RUBBER COATED
4 SEALANT
5 NYLON BARRIER
6 BUNA RUBBER COATED
FABRIC, OR POLYURETHANE
INNER LINER

7 VINYLITE LACQUER
8 NYLON FABRIC
9 NYLON FABRIC
10 SEALANT
NAT CRUDE (100%)
11 NYLON BARRIER
12 HYCAR LINER

Figure 7-3. Typical Self-Sealing Construction

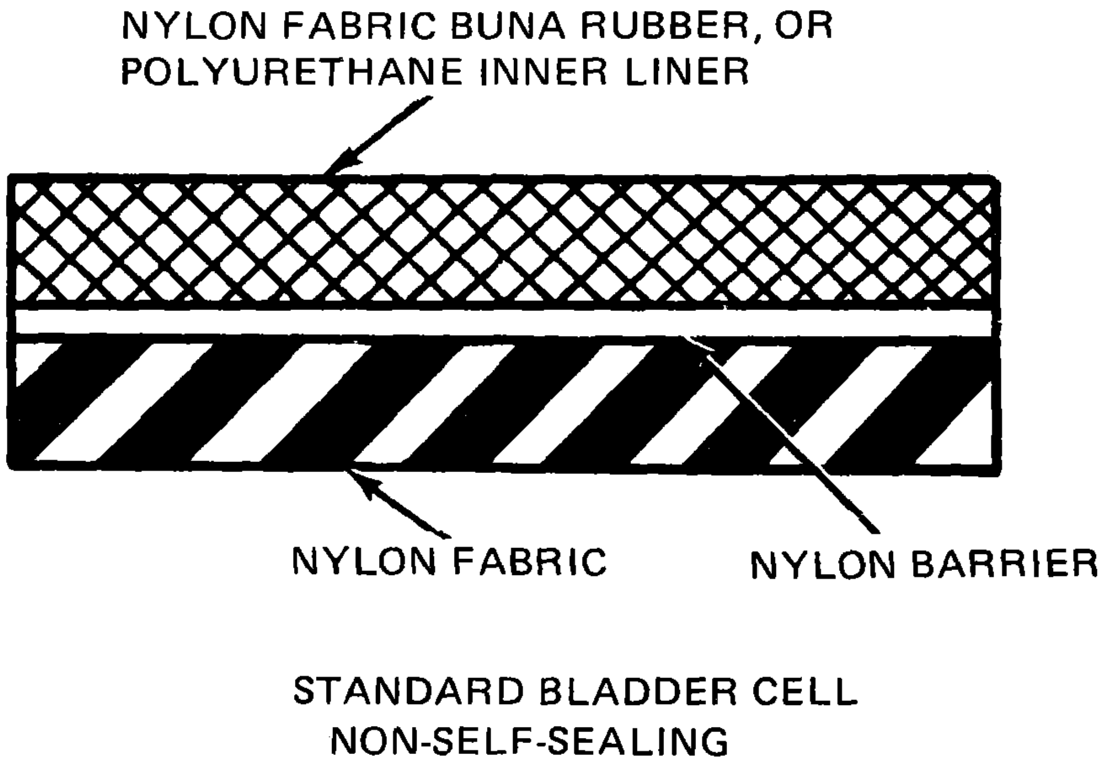


Figure 7-4. Non-Self-Sealing Construction

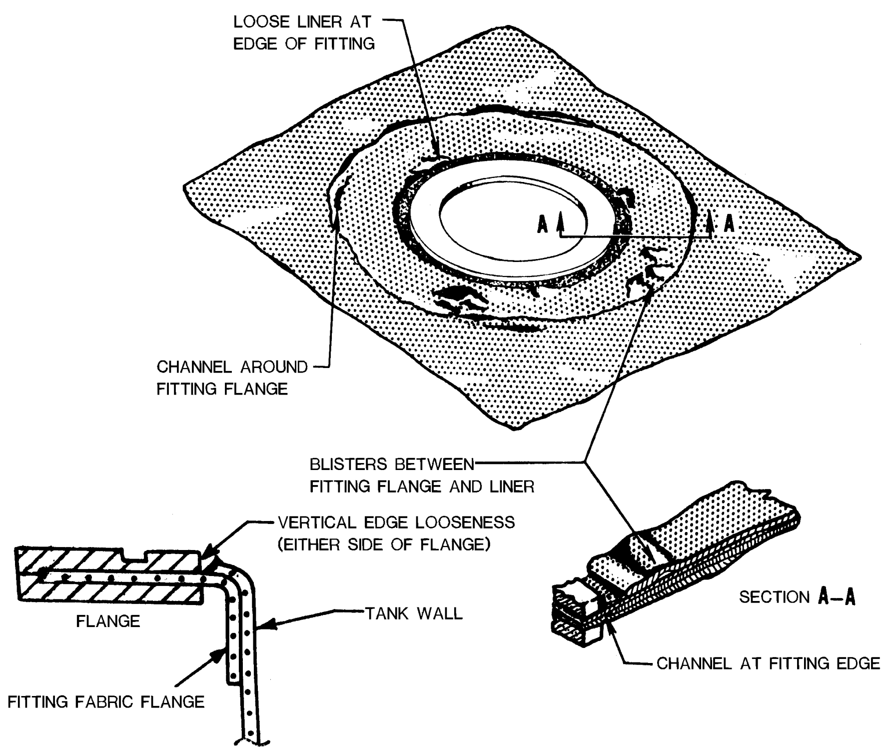


Figure 7-5. Channel Blisters and Loose Areas

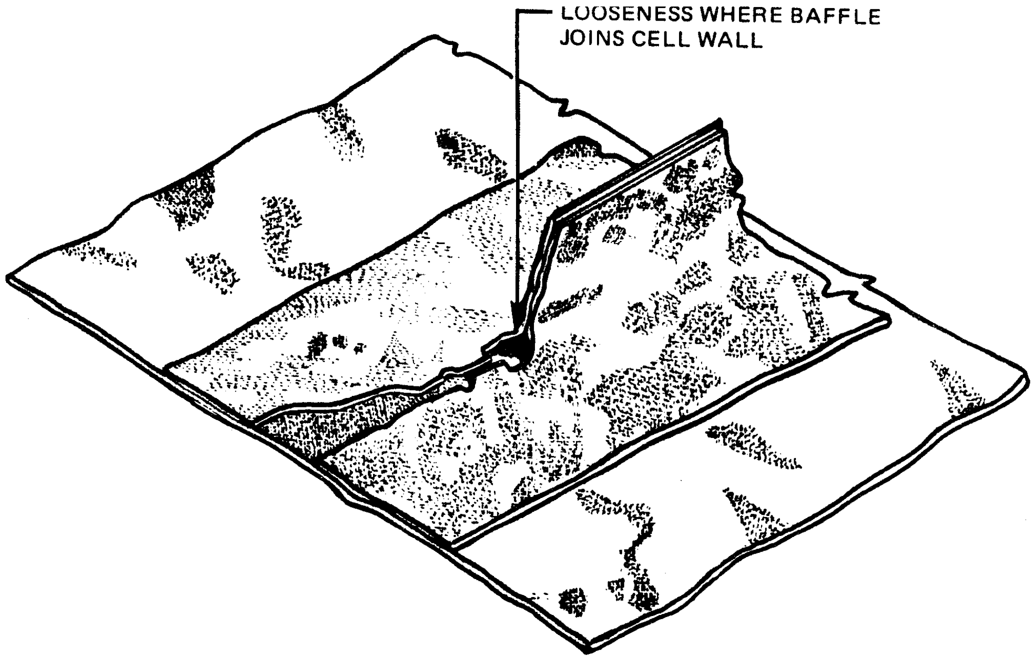


Figure 7-6. Loose Baffles

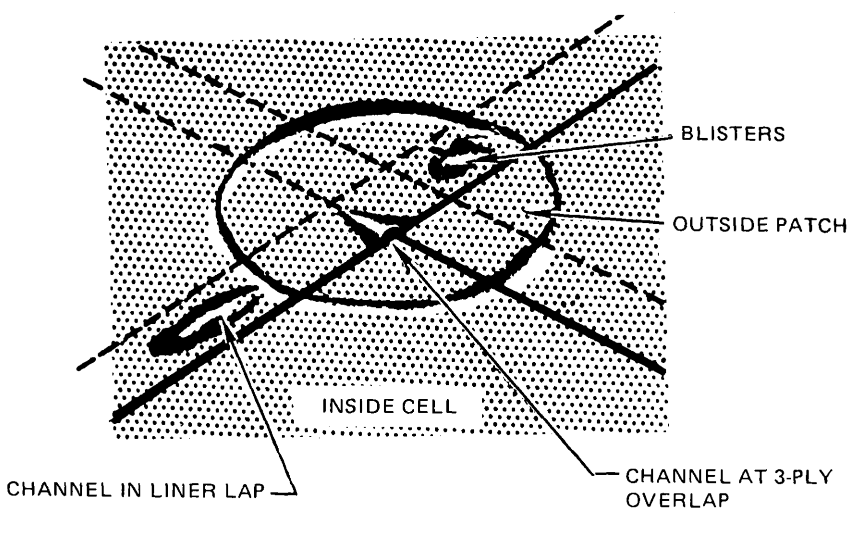


Figure 7-7. Loose Patches

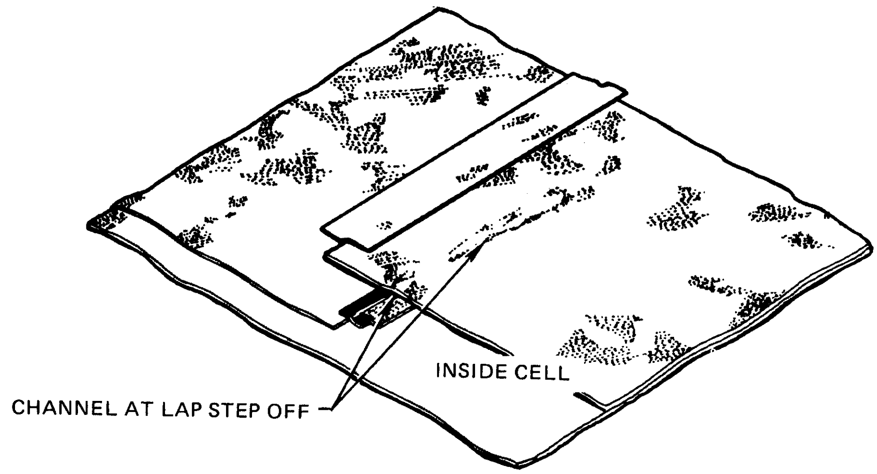


Figure 7-8. Channel at Lap Steps

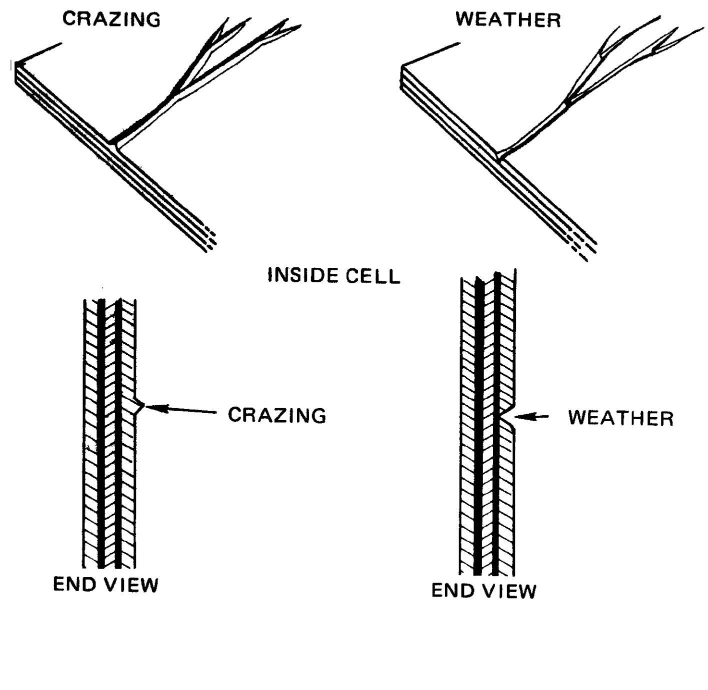


Figure 7-9. Weather and Crazing

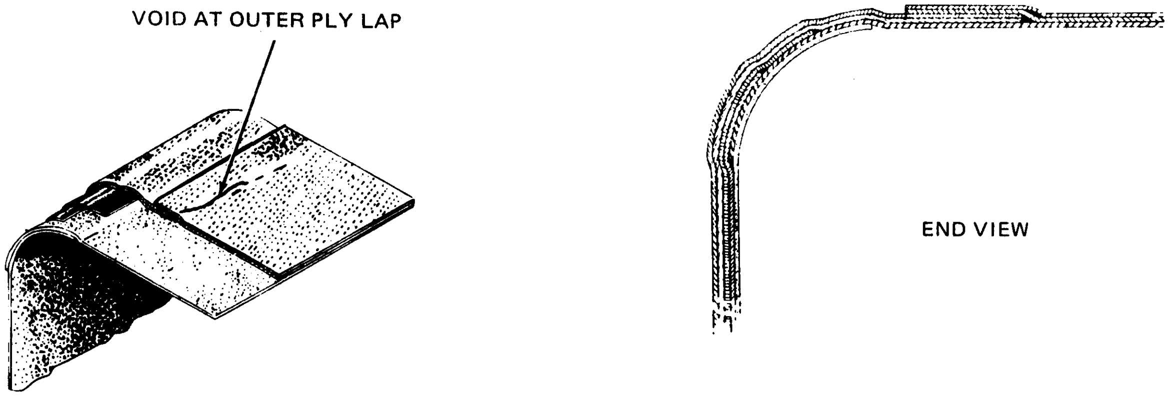


Figure 7-10. Lap Channels

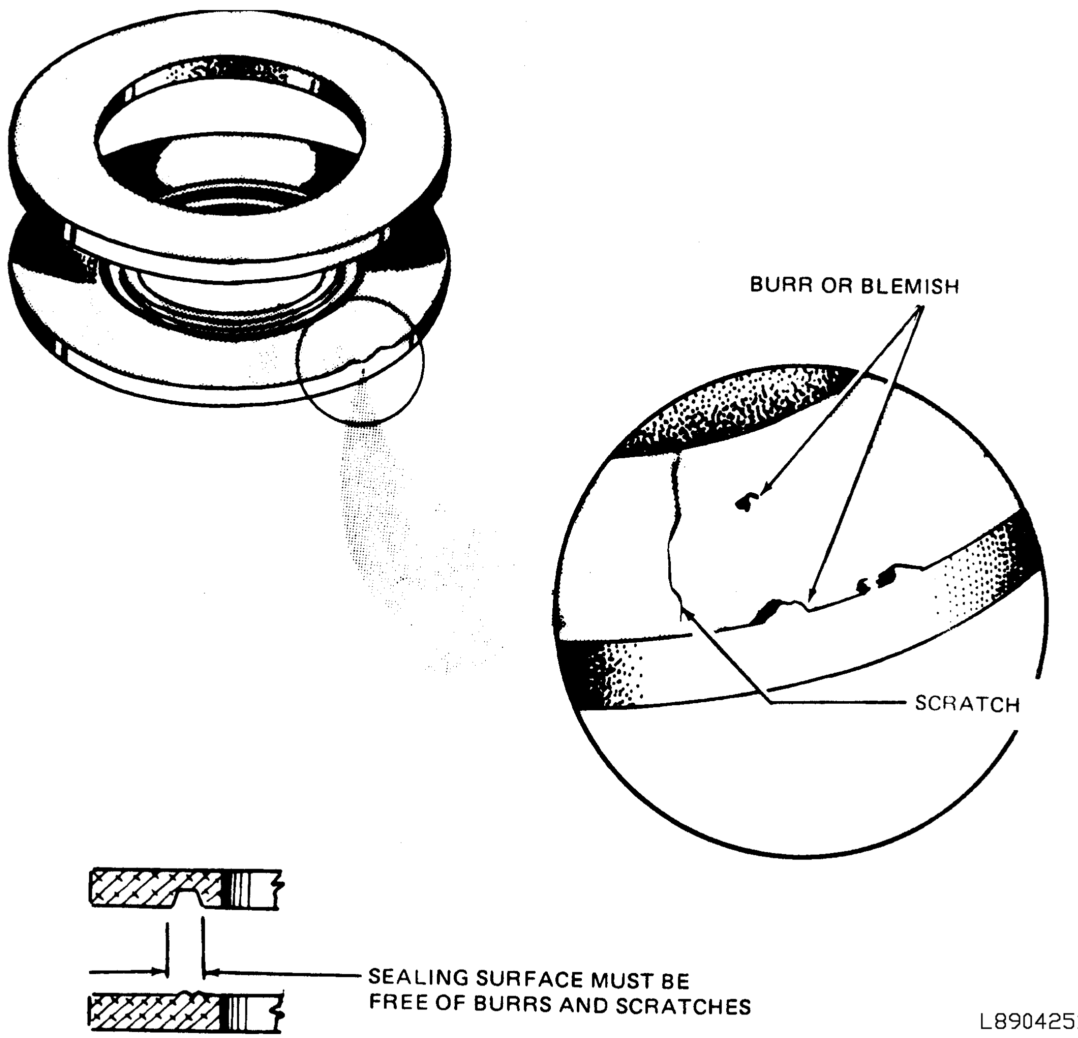


Figure 7-11. O-Ring Fitting Inspection

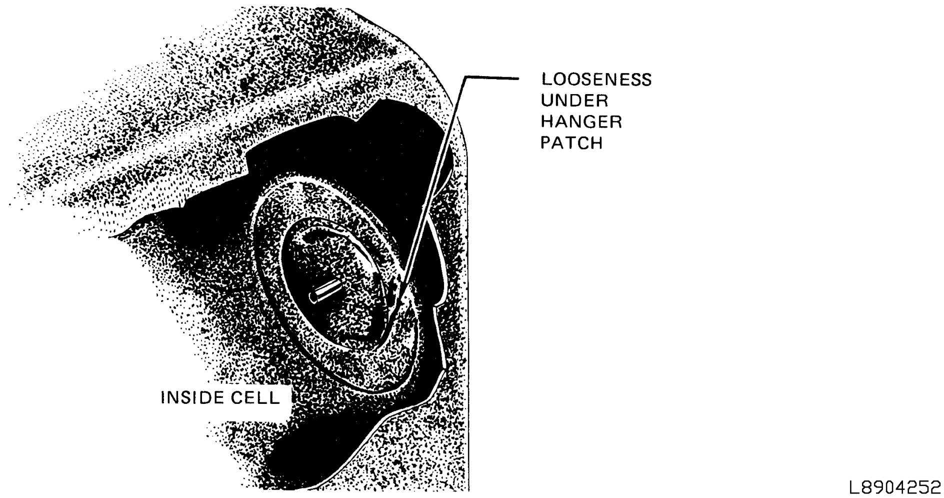


Figure 7-12. Looseness Under Hanger Fitting

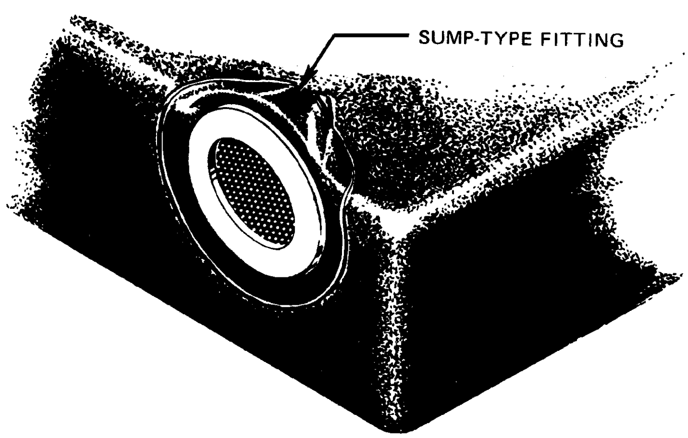


Figure 7-13. Sump Fitting

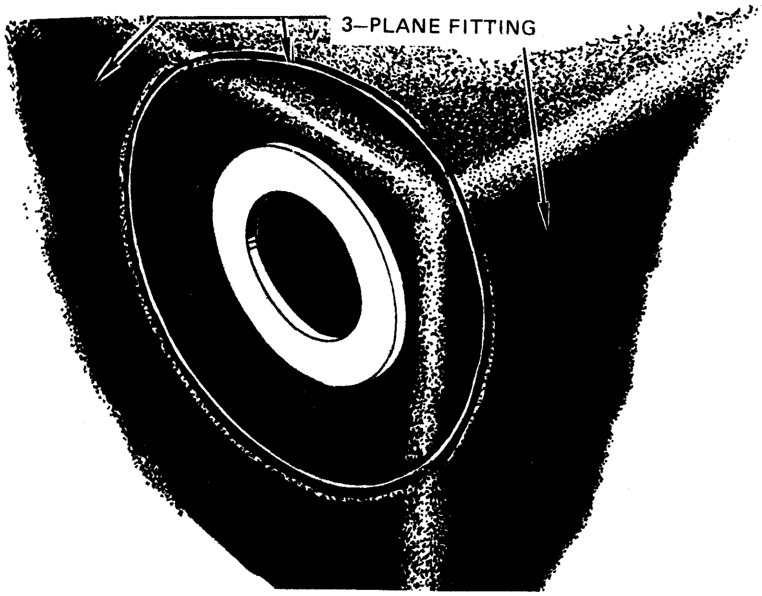


Figure 7-14. Three-Plane Fitting

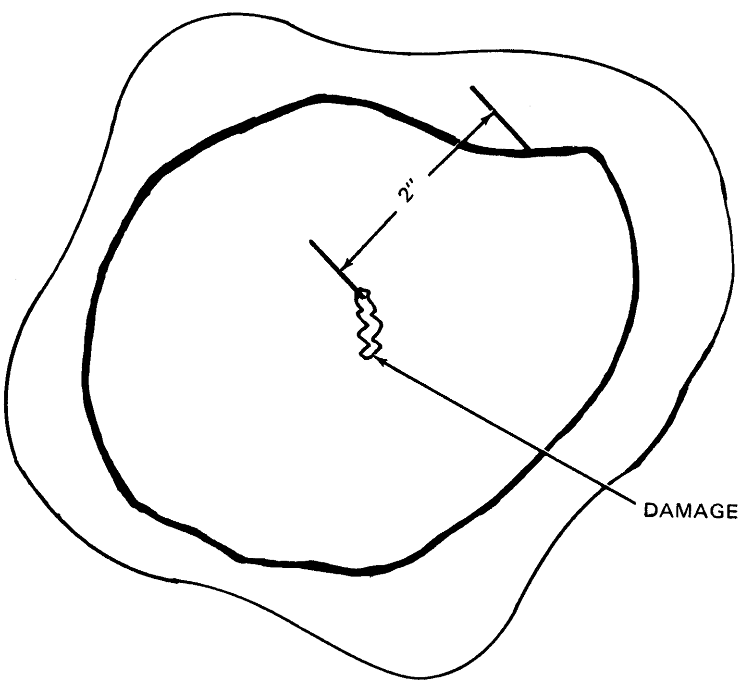


Figure 7-15. Marking Area to Be Repaired

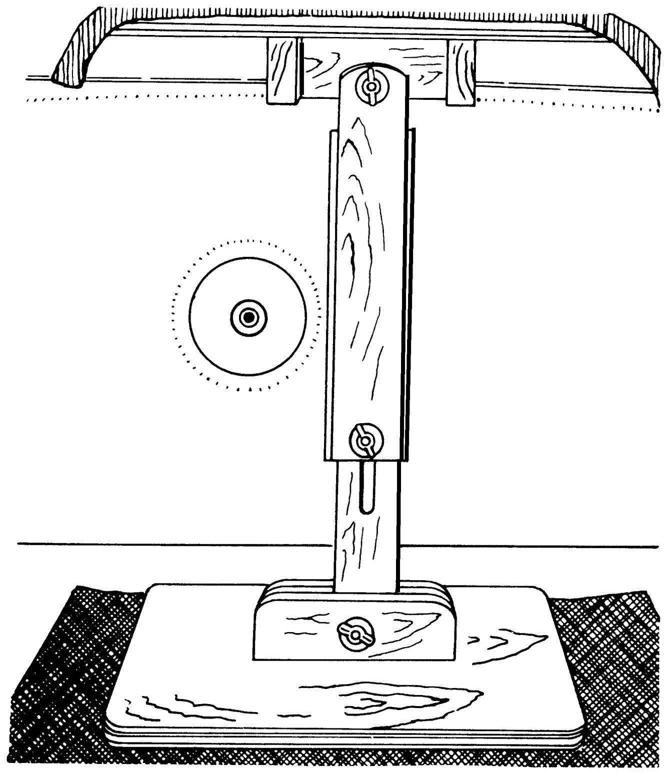


Figure 7-16. Pedestal for Supporting Cells

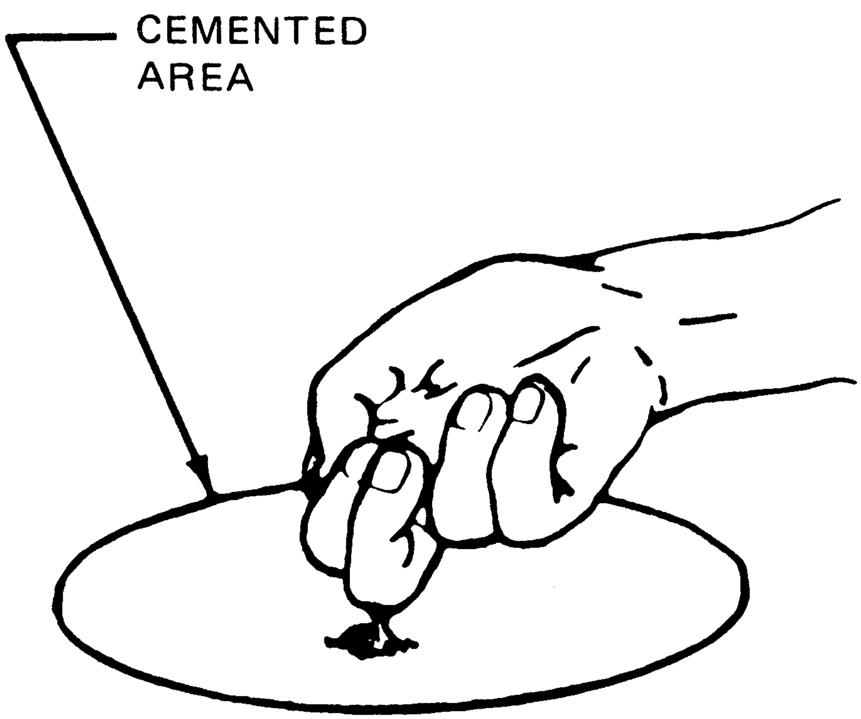


Figure 7-17. Knuckle Test

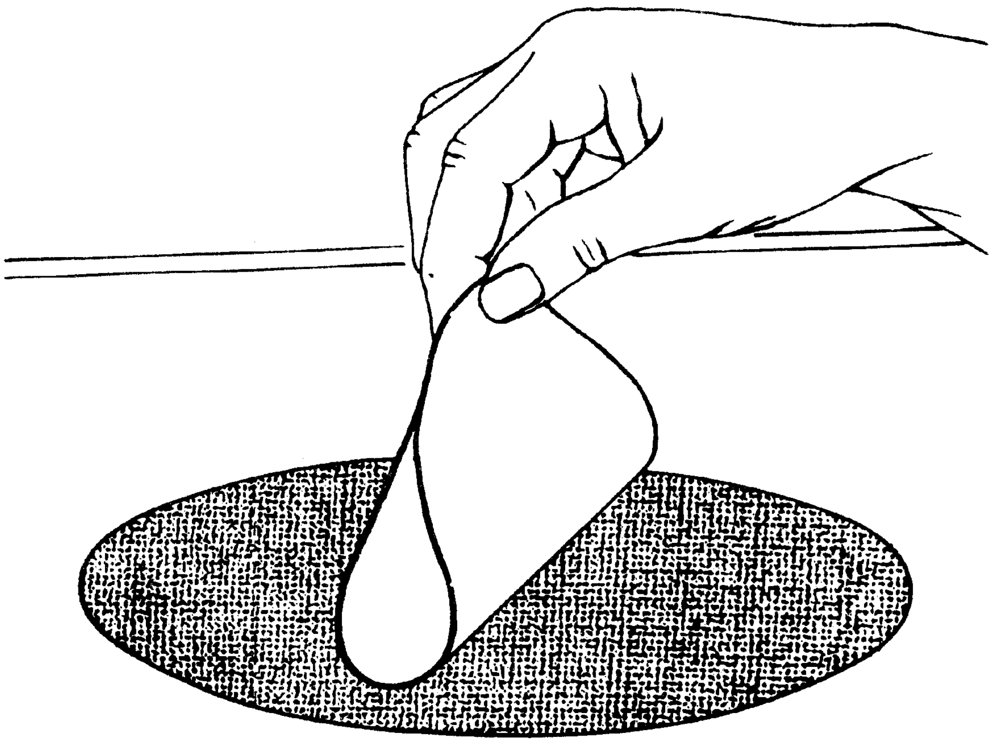


Figure 7-18. Centering Patch

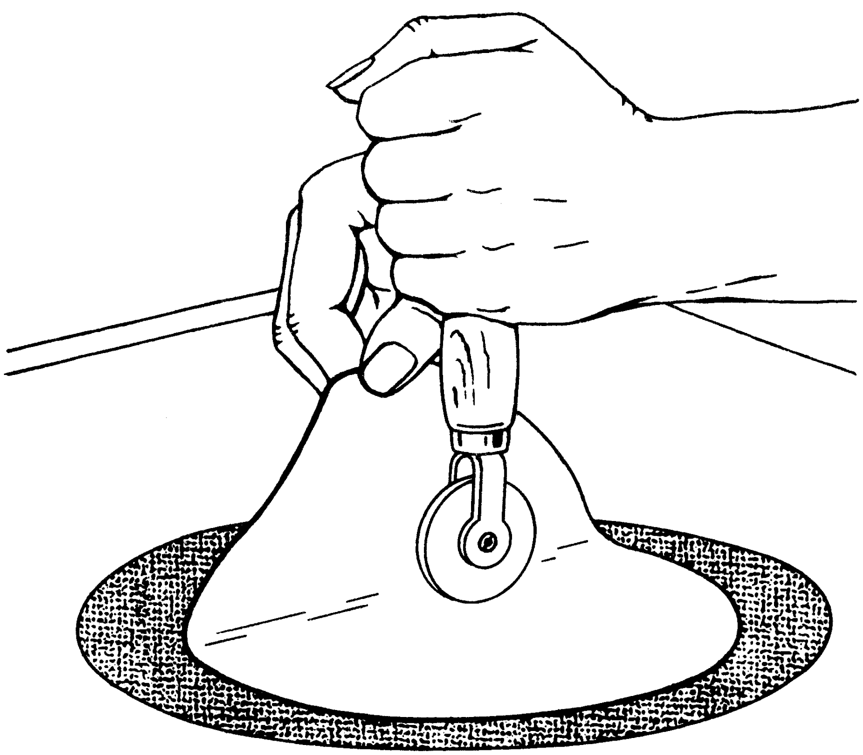


Figure 7-19. Rolling Down Patch

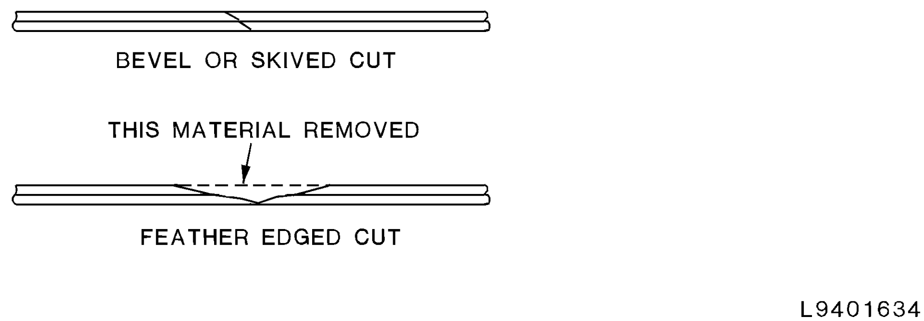


Figure 7-20. Sectional Views of Corner Patch

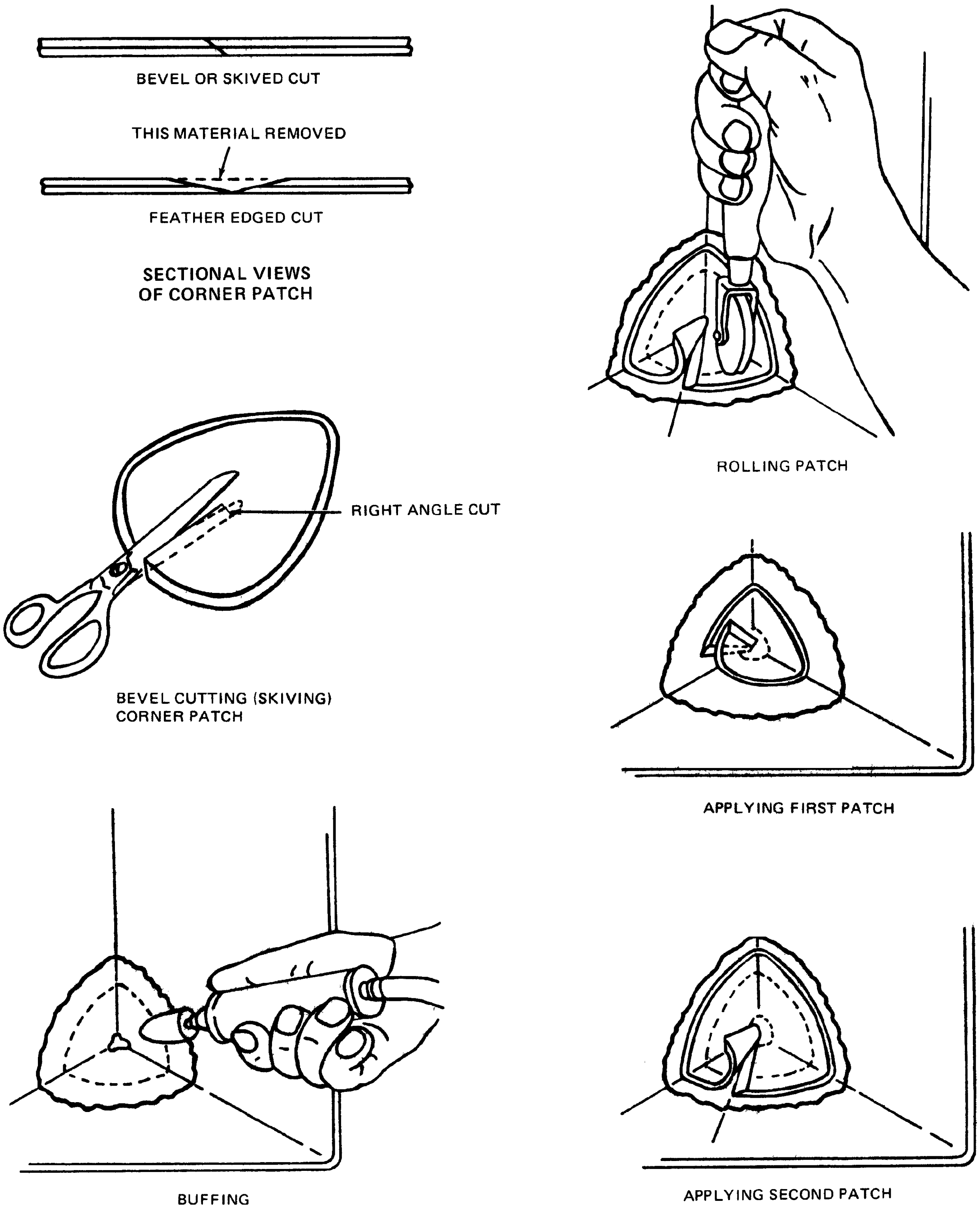


Figure 7-21. Inside Corner Repair

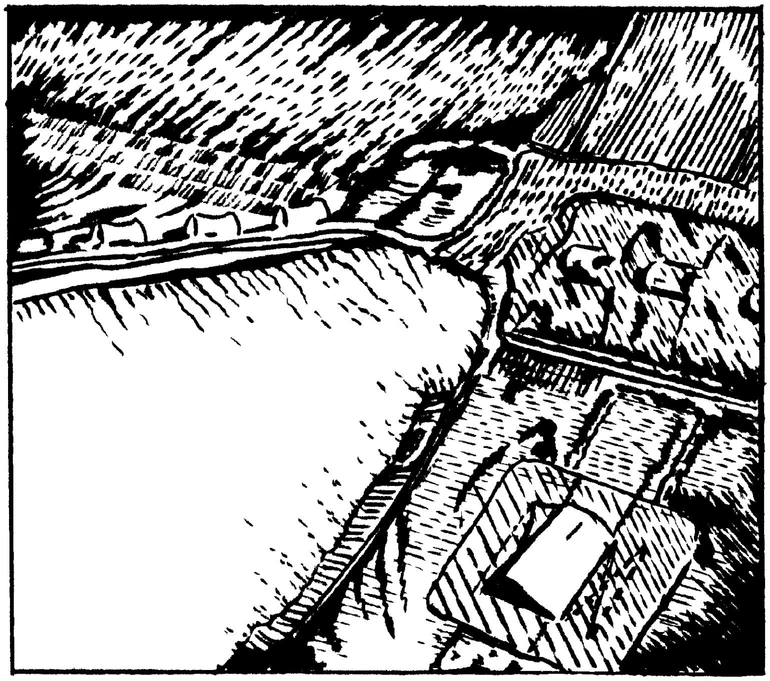


Figure 7-22. Ruptured Inner Liner

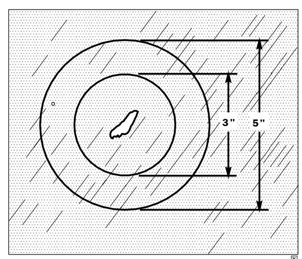


Figure 7-23. Marking Cell

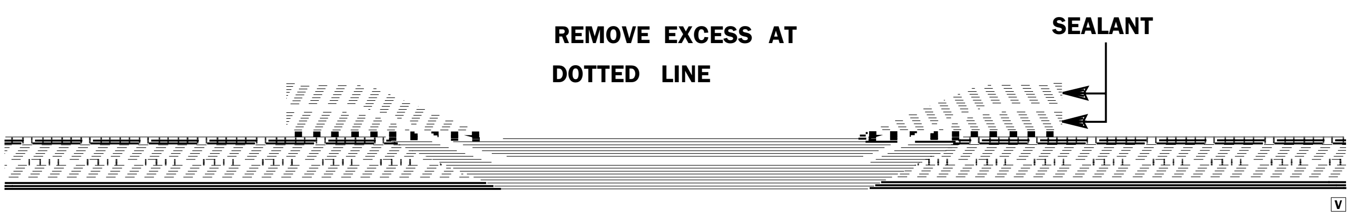


Figure 7-24. Built-up Cell

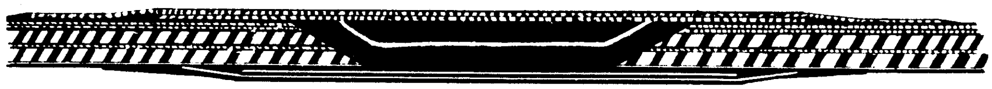


Figure 7-25. Finished Built-Up Cell

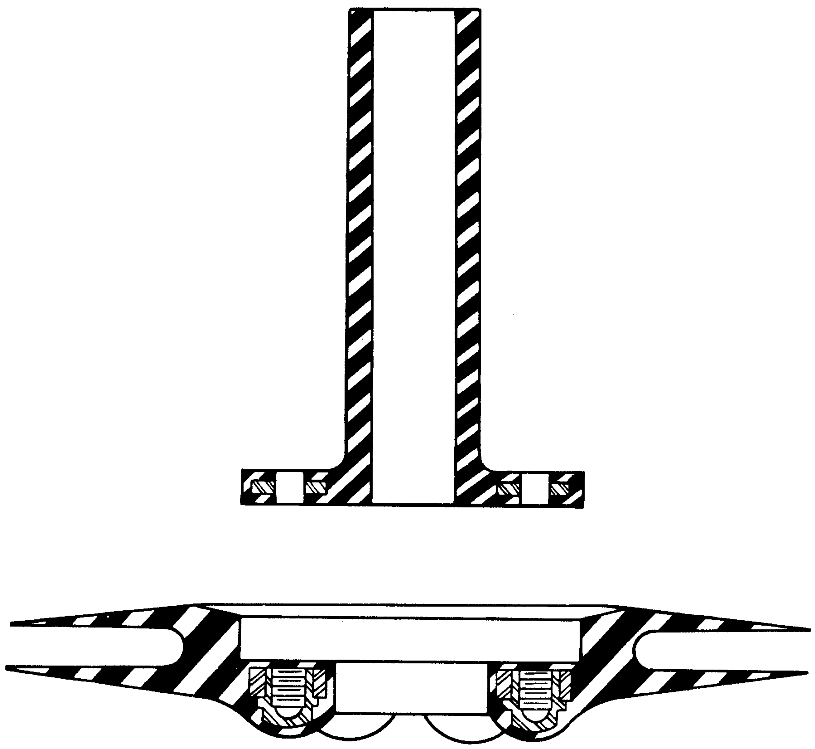


Figure 7-26. Two-Piece Fitting

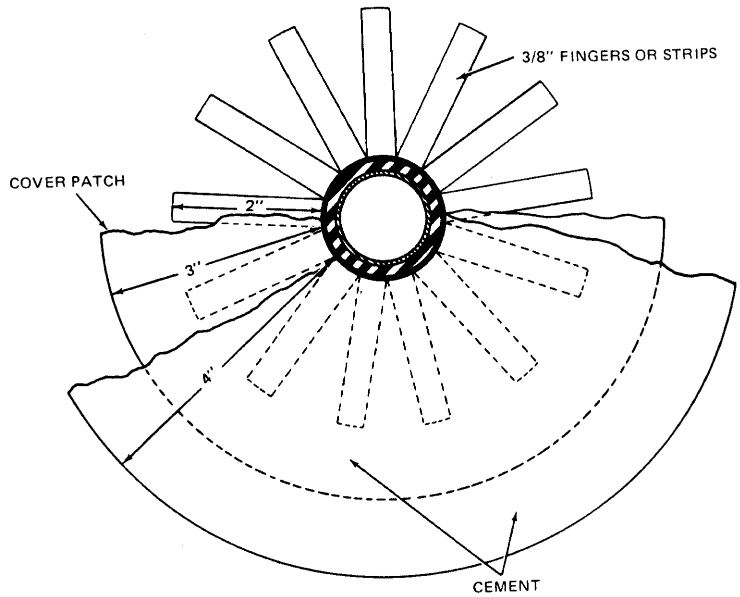


Figure 7-27. Wrap Application

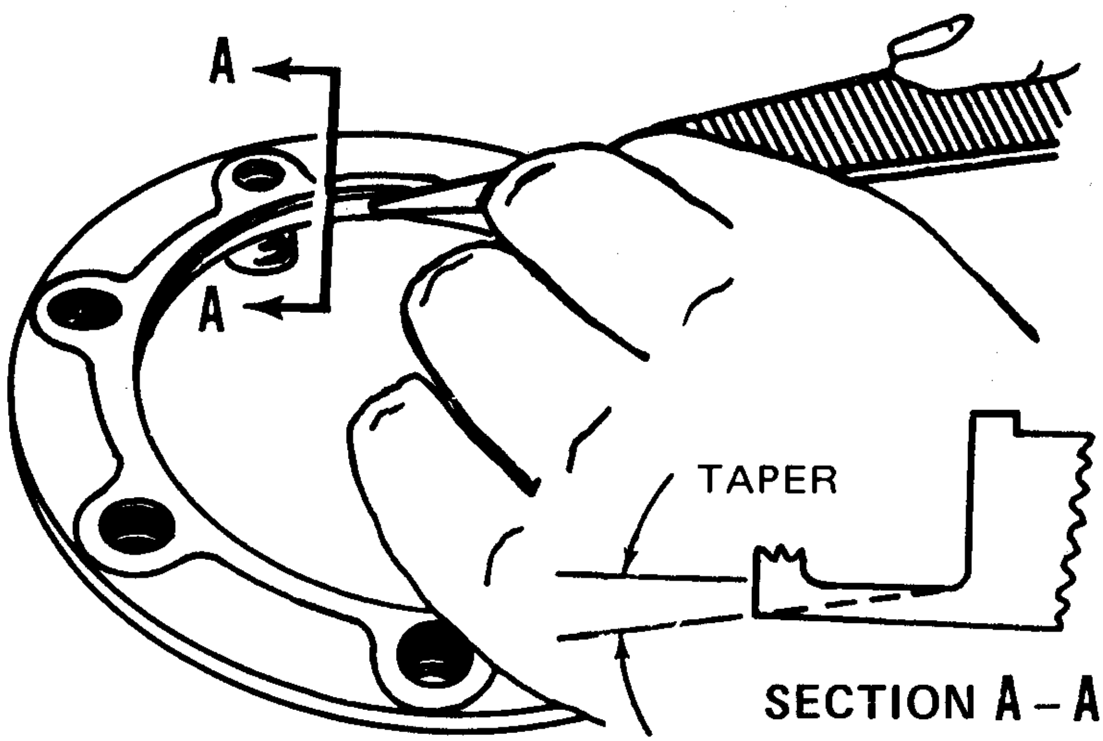


Figure 7-28. Fitting Flange Break

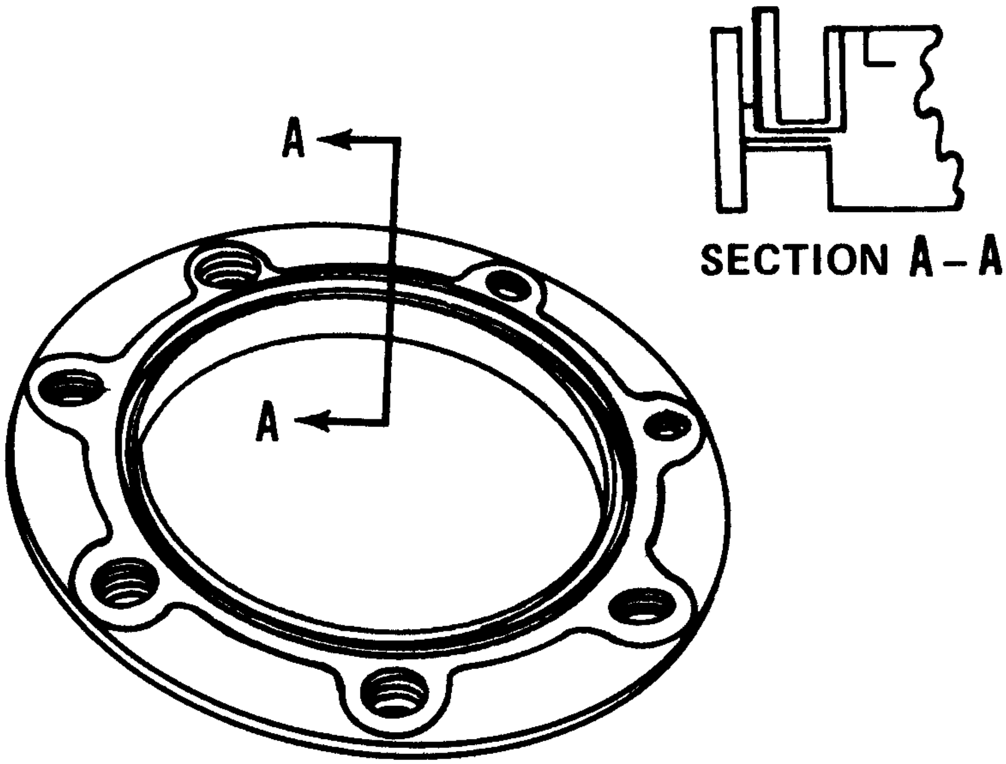


Figure 7-29. Retainer Ring Installation

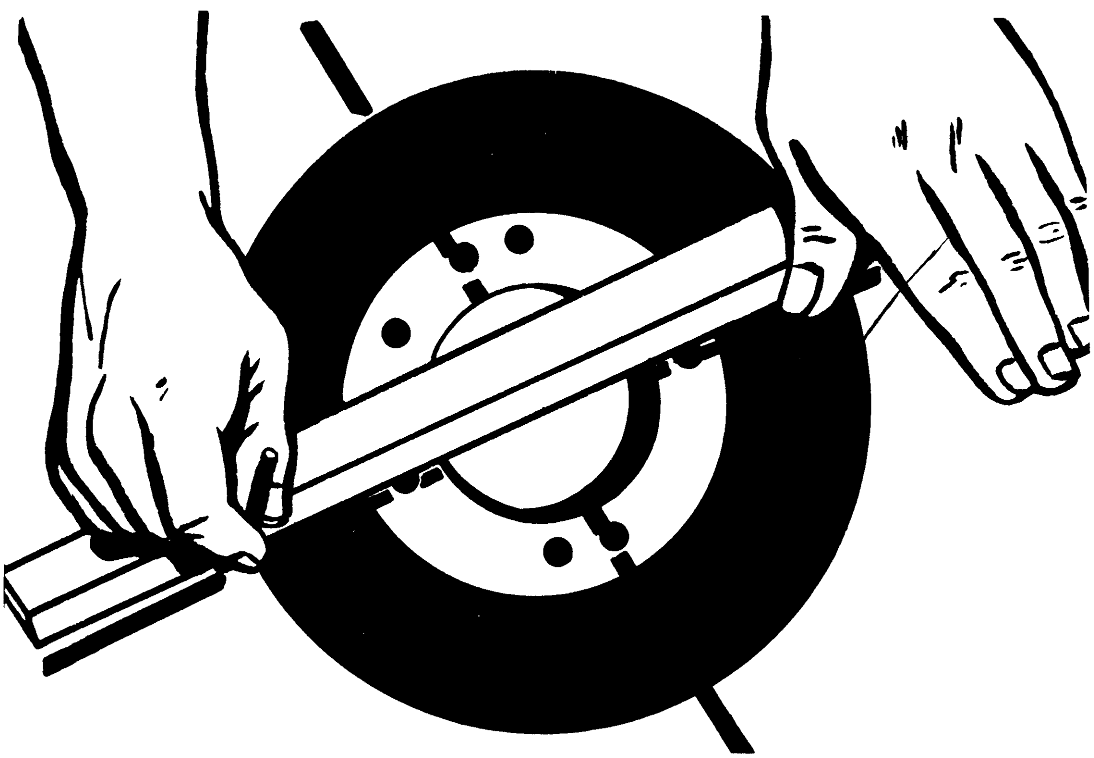
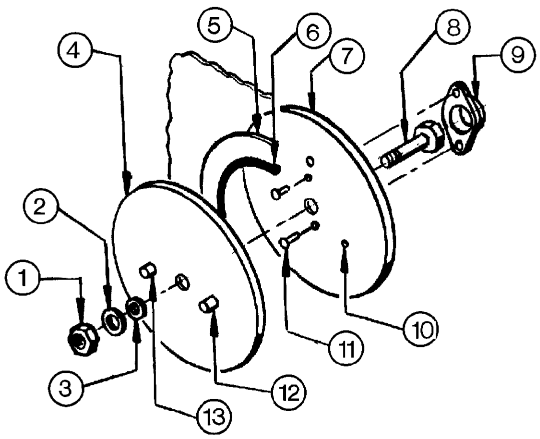


Figure 7-30. Locating Fitting



1. NUT
2. WASHER
3. SEAL
4. COVER PLATE
5. FUEL CELL FITTING
6. O-RING
7. SUPPORT PLATE
8. BOLT
9. BOLT RETAINER
10. AIR PASSAGE HOLES
11. RIVET
12. AIR INLET FITTING
13. MANOMETER LINE FITTING

Figure 7-31. Fuel Cell Fitting Leak Test Cover Plate

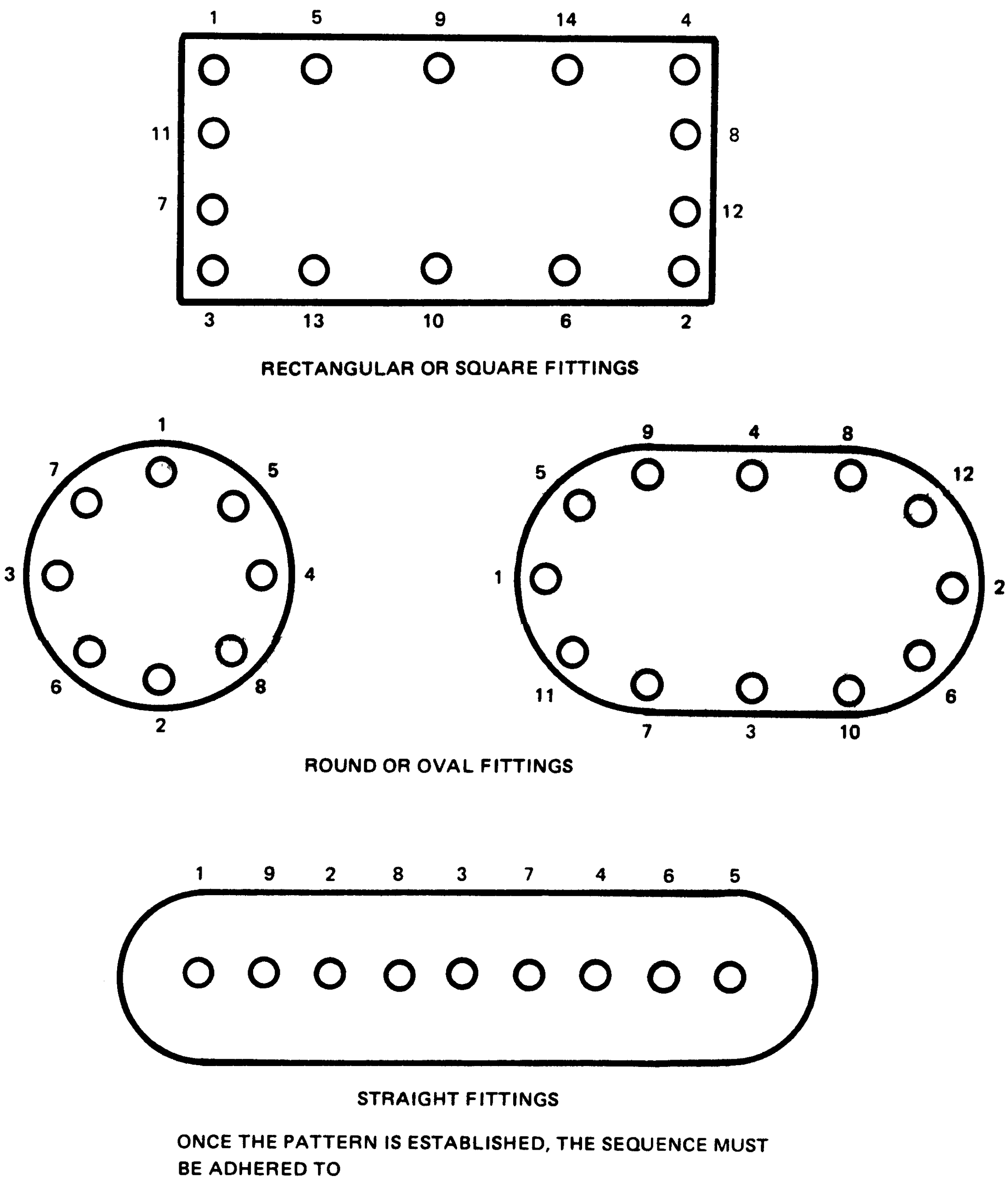
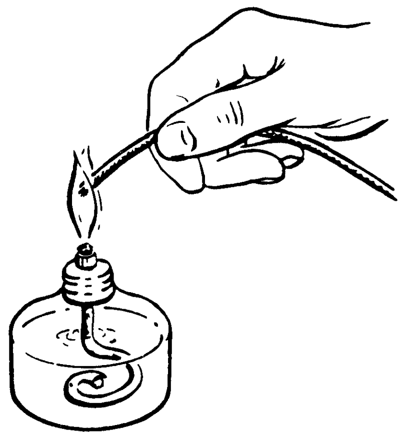
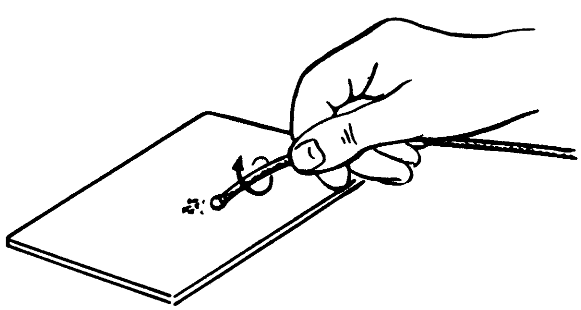


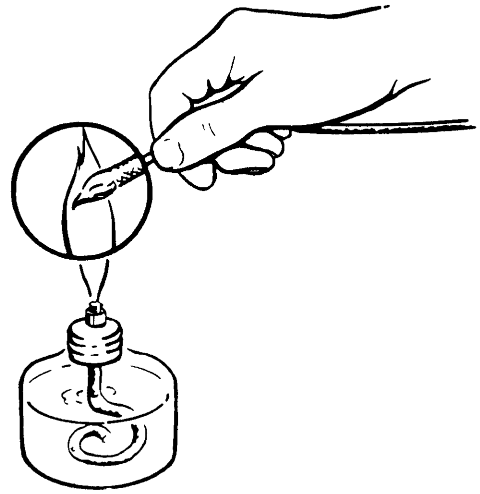
Figure 7-32. Torque Pattern for Bolts



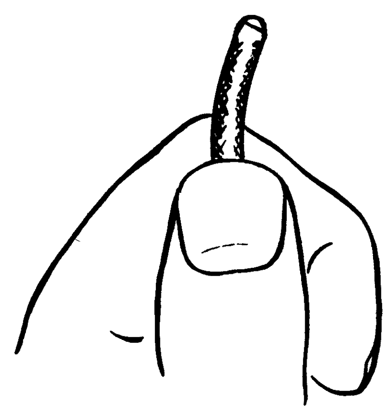
1 MELT END OF NEW LINE UNTIL NYLON BEGINS TO BURN



2 ROLL MELTED END ON CARDBOARD OR ANY FLAT SURFACE TO REMOVE EXCESS NYLON AND TO FORM SHARP T'P ON END OF LINE



3 REMOVE SHARP TIP BY REHEATING MOMENTARILY IN FLAME



4 ROUNDED END OF LACING LINE PROPERLY PREPARED FOR USE

Figure 7-33. Replacing Lacing Cords

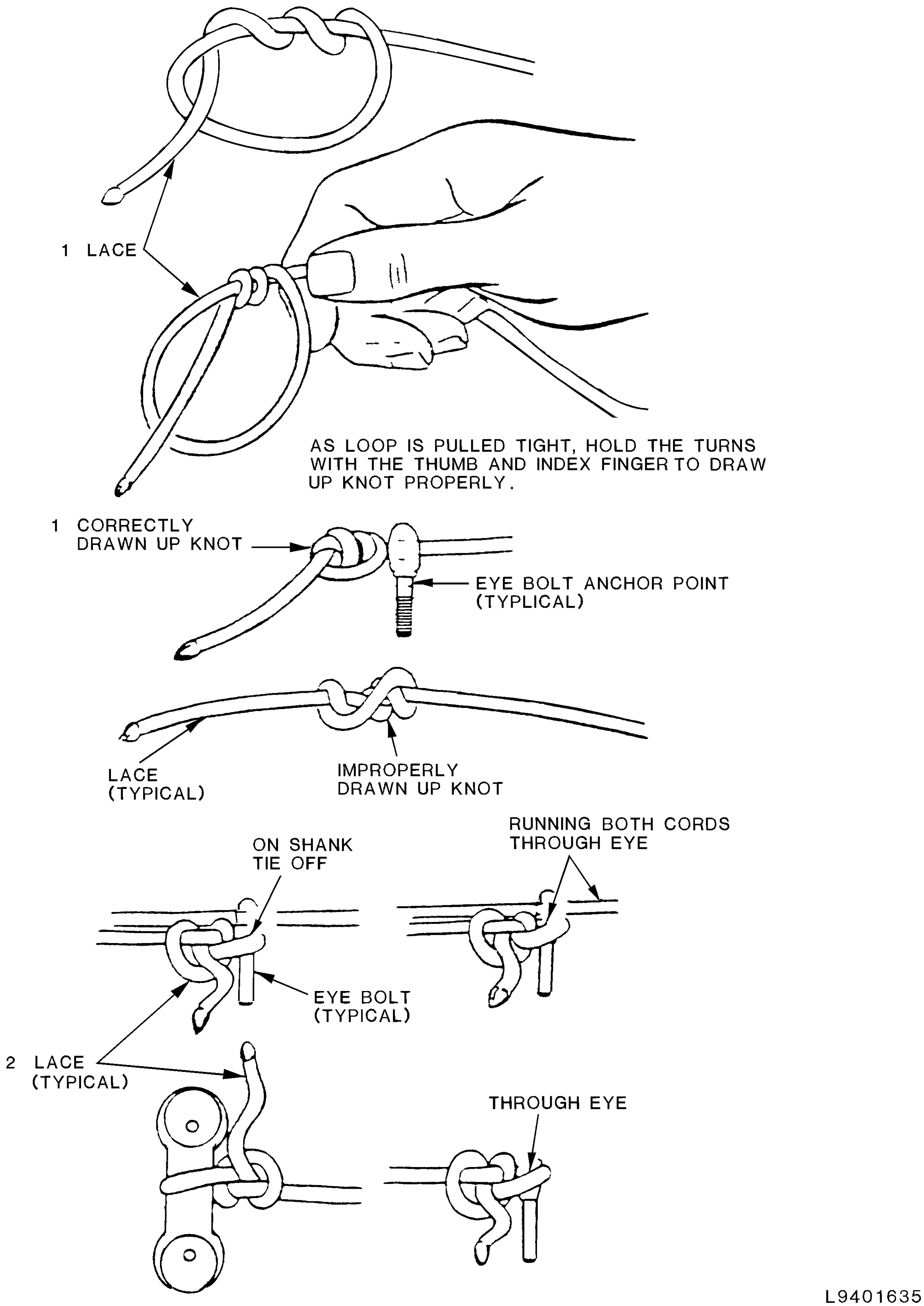


Figure 7-34. Lacing Cord Knots

CHAPTER 8
EQUIPMENT AND MATERIALS

8.1 PURPOSE.

8.1.1 This chapter contains information on selected equipment and materials needed to accomplish integral tank and cell repair using instructions provided in this manual.

8.2 GENERAL.

8.2.1 The equipment and material listed in this manual are not the only products available but they have been proven to perform satisfactorily. This chapter contains a brief description of many of the products.

8.2.2 A table containing selected information on each product is included in this chapter as Table 8-1.

8.3 EQUIPMENT AND MATERIAL SUBSTITUTION.

8.3.1 Proper equipment and material selection requires review and analysis of many criteria before a product can be approved for use. These criteria include but are not limited to: material interactions, environmental considerations, safety considerations, health considerations, and cost.

8.3.2 Equipment and materials shall not be substituted without proper authorization. Improper material selection has been proven to cause problems ranging from corrosion to adhesive bond failure. The use of improper equipment can create a safety hazard, an environmental hazard, or could damage the aircraft. The MAJCOM Functional Manager for Aircraft Fuel Systems, Weapon Systems Managers, and the Office of Primary Responsibility (OPR) for this technical order are the only organizations approved for authorizing substitutions for equipment and material required by this manual. The MAJCOM Functional Manager for Aircraft Fuel Systems, Weapon Systems Managers, and the OPR for this technical order should work together and advise each other of newly approved equipment and materials. Local and MAJCOM Environmental Management, BEF, Fire Department, and Safety Offices may prohibit the use of materials and equipment, recommend substitute material and equipment but they shall not authorize material and equipment substitutions.

8.4 PERSONNEL EQUIPMENT.

8.4.1 Apron. An apron is used to provide protection from chemical splashes.

8.4.2 Head coverings. A cap or other head covering is used to protect the scalp from contact with chemicals and to prevent hair oil from contacting the aircraft. The head covering must be chemical and static resistant.

8.4.3 Coveralls. The coveralls shall be static free with velcro or non-sparking button closure, closed cufflet and anklet. The tri-layer coverall used for wet fuel operations has a middle layer which offers increased protection from liquid penetration. The cotton coverall may be used for operations that do not include direct, prolonged contact with fuel.

8.4.4 Gloves. Gloves are used to allow free movement and to protect hands from sealant and adhesives. Chemical-resistant, cotton or surgical gloves may be used to provide protection from fuel and solvents. Gloves must be static-resistant.

8.4.5 Knee and Elbow Pads. Knee and elbow pads are used to provide cushioning when working in tanks. If used, they must be static resistant.

8.4.6 Footwear. Footwear shall be static-resistant and must not include spark-producing nails or metal plates. Clean shoes or boots with or without footwear covers may be worn in integral tanks. Static-resistant booties shall be worn in bladders.

8.4.7 Undershirt. Crewneck, quarter sleeve, cotton undershirts may be worn under any approved outer garment. Material shall be at least 50 percent cotton. White is the preferred color but other colors are acceptable.

8.4.8 Respirator. Respiratory protection shall be selected, used, and maintained in accordance with AFOSH 48-137. The entry authority and local BEF are responsible for selecting respirators.

8.5 SAFETY EQUIPMENT.

8.5.1 Air Purifier Cart. The cart is used to remove airborne contaminates, e.g., oil vapor, carbon monoxide, from shop air. The cart shall provide air conforming to specification BB-A-1034 Grade D. The cart shall be tested every 45 days. (Refer to AFOSH 48-137 and TO 42B-1-22).

8.5.2 Combustible Gas Alarm (Area Monitor). The alarm is used for area monitoring. Alarm shall be preset to 20 percent LEL. The combustible gas alarm shall be used when the aircraft has been serviced with AVGAS or JP-4.

8.5.3 Combustible Gas Indicator. Is used to check the LEL of fuel tanks. This indicator shall be capable of accurately determining the LEL of all common aviation fuels used by the Air Force. The indicator shall be accurate for entire range of LEL for which it is used.

8.5.4 Oxygen Analyzer. The analyzer is used to determine oxygen content of integral tanks and fuel cells.

8.5.5 Signs. "DANGER - OPEN FUEL TANKS - UNAUTHORIZED PERSONNEL KEEP OUT" and "NO FUELED AIRCRAFT PERMITTED IN THIS FACILITY" may be locally produced or requisitioned in accordance with AFOSH 91-25.

8.5.6 Lights, Lamps and Lanterns. With the exception of the hand held flashlights (6-volts and less); lights, lamps and lanterns shall be approved for use in a Class I, hazardous area and listed in TO 35F5-1-2. The hand held flashlight shall be approved and marked/labeled for use in a Class I, hazardous area.

8.5.7 Streamers and Tags. Streamers and tags shall be used to denote warnings and danger as appropriate. Red "REMOVE BEFORE FLIGHT" should be requisitioned from supply. Yellow "CAUTION - REMOVE BEFORE FUELING/DEFUELING" may be requisitioned from supply or locally manufactured (drawing is available from WR-ALC).

8.5.8 Fire Extinguishers. A 150 pound HALON 1211 fire extinguisher or equal (refer to TO 00-25-172) shall be in each open area.

8.6 LEAK DETECTING AND TRACING EQUIPMENT.

8.6.1 Vent Plugs, Caps and Cover Plates. Requisition from supply or local manufacture as necessary.

8.6.2 Water Manometer. The manometer is used to measure the pressure in the tank (either negative or positive) and provides pressure relief should preset pressures be exceeded.

8.6.3 Blacklight. This light is used with florescent dye to detect leak paths. The blacklight shall be approved for use in a Class I, Division 1, hazardous location and meet the requirements of NEC Article 501.

8.6.4 Leakage Tracing Device. This box is composed of controls to which an external air pressure source is connected. The pressure source is converted to a vacuum source or dye injection source with reservoir.

8.6.5 Vacuum Cup. This plastic vacuum cup is provided with the leakage tracing device to confirm a sealant repair or to check under head-sealed fasteners by pulling air or dyed fuel through structure and into the plastic container.

8.6.6 Cup, Vacuum Pressure. This double cup assembly is a vacuum segment to hold the cup in place and a pressure segment to inject dye into the leak path.

8.6.7 Dye Injector. This injector is a hollow bolt used to inject dye for tracing leaks.

8.6.8 Manometer. Manometer are used to measure either positive or negative pressure inside fuel tanks. Both "U" shaped and vertical manometers are used. The only fluid authorized for use in the manometer is a fifty percent mixture of water and ethylene glycol. Field sized manometers are shown in figure 8-3 and figure 8-4. Smaller manometers are normally used for cell repair. When the water manometers is the only overpressure protection for a repair operation, the column height and, in the case of a vertical (single column) manometer, the size of the water box are important selection and sizing criteria for rapid blowout and pressure relief. Both valves should be minimal for the applicable working pressures.

8.6.9 Plugs/Caps/Coverplates. These are used to perform pressurization and vacuum tests. They require safety streamer.

8.6.10 Pressure Box. This box is used to apply pressure to a small area over the exterior leak point from which air may be forced or dye injected back along the leak path to the leak source. This may be used in the Dye Injected Methods, Blow Back Methods and Vacuum Methods.

8.6.11 Vacuum Pump. Instrument used to pressurize fuel tanks during leak detection processes. This pump is used in Vacuum Methods.

8.7 SUPPORT EQUIPMENT.

The following items are authorized to be used in fuel system areas and may be attached to an aircraft during fuels system repair:

8.7.1 Air Conditioners. Trailer mounted ground support electric, gasoline or diesel powered air conditioners can be used for fuel cell/tank maintenance when conditioned, temperature controlled air is required. This equipment is not explosion-proof and must remain outside the fuel cell repair area. If heated conditioned air is required, the temperature applied must never exceed 150°F. The A/M32C10 air cycle conditioner (all models) can be used for this purpose. Temperature range on the air cycle air conditioner is from 48°F to 200°F.

8.7.2 Air Mover. The air mover operates on the venturi system. The air is supplied from a compressor to the air mover. The unit is excellent for removing vapors through vents, fillers or other small openings. (See figure 8-5.)

8.7.3 Type MA-1 Blower. The type MA-1 is an explosive proof non-spark producing blower and may be used inside the fuel system repair area. The blower is an excellent mass air mover used during blow or exhaust purging. Proper bonding shall be accomplished before starting the blower. The units shall be bonded to the aircraft before attaching the duct to the fuel cell/tank opening. The MA-1 blower duct shall be obtained from stock and inspected to assure that the reinforcement coil is bonded to the outlet ring. In the event it is not, the ducts shall be modified to complete this bond prior to use. The filter for the MA-1 blower is designed to prevent the blower from picking up sand, dust and dirt and blowing into the cell/tank. The filter is a locally manufactured item. The drawing shall be obtained through WR-ALC/TIL, Robins AFB, GA 31098-5609. Filters in the assembly should be cleaned and replaced as required. Blower equipped with a filter may be used to supply air into cell/tank for personnel comfort when accomplishing repair.

8.7.4 Fuel Cell/Tank Servicing Cart. This cart is used as a central point for breathing air supply bottles, regulators and respirator hose. It is to be used to store material, personnel equipment and provides outlets for respirators. The cart is to be bonded. Each time a tank entry is made using cylinder breathing air from cart, a standby person shall be at the cart.

8.7.5 Nitrogen Cart. There are two approved carts that can be used in supplying nitrogen to fuel system when inerting is required. Carts shall be marked as stated in TO 35-1-3 and TO 42B5-1-2.

8.7.6 Vacuum Cleaner. This cleaner is an explosion-proof air-operated cleaner. The cleaner may be used to remove any fuel from cell/tank that will not drain from sumps, drains or other normal drain procedures. The cleaner shall be bonded to the aircraft prior to starting.

8.7.7 Air Compressor. A portable cart mounted air compressor which can be used for fuel cell/tank maintenance when a compressed air source is required. Non-explosion proof air compressors are kept outside the fuel system repair area. When used as an air supply to personnel entering fuel cell/tank, it is connected directly to the air purifier cart which removes air contaminants. Explosion proof compressors are in the MB-1 series.

8.7.8 Container. Approved safety containers used in draining fuel from aircraft can be obtained in sizes from two quarts to 1000 gallons. Locally manufactured or procured containers shall meet the requirements of AFOSH 91-25 and TO 00-25-172.

8.7.9 12-Inch duct for Dock Installed Purge Equipment. The ducts received from stock must be modified to insure that the reinforcement coil is bonded to the end ring prior to use.

8.7.10 Heaters. These are portable heaters used to supply heated air to a work area, fuel cells/tanks when purging, and curing sealants and coatings. The following are approved heaters:

8.7.11 Type H-1 heaters are not explosion proof, but have combustion chambers that are sealed from the ventilating chambers. These heaters can be connected through a plenum chamber to the fuel cell/tank opening using the ducts supplied with the unit.

8.7.12 HDU/13. The HDU/13 is an explosion proof heater that may be operated inside the fuel system repair area, hangar or nose docks. These heaters can be connected directly to the fuel cells/tank opening through the ducts supplied with units. Temperatures may be controlled on the heater by manual control as desired from 40°F to 200° F. Any selected temperatures above a maximum ambient will be automatically maintained regardless of airflow or ambient temperature changes within the 100,000 BTU/Hour capacity of the heater. This heater can be used to purge aircraft fuel cells/tanks (blow/exhaust purge method) and to cure sealant and coatings.

8.7.13 Plenum Chamber. The plenum chamber is a locally manufactured item which is used to reduce the air temperature from a heater by mixing with ambient air.

8.7.14 Ambient Air Breathing Pump. This portable, oil-less, pump is used to deliver low-pressure ambient air for up to three people at a time.

8.7.15 Pneumatic Powered Fan. This 12-inch fan can be used for either blow or purge of aircraft fuel.

8.7.16 Eight-Inch Pneumatic Powered Blower. This blower may be used to blow purge aircraft fuel tanks during fuel systems maintenance.

8.7.17 Rubber Buckets. Approved buckets may be used to drain small amounts of fuel from aircraft. These containers are 3 gallon capacity and are non-conductive so they need no bonding.

8.8 REPAIR EQUIPMENT.

The following items are authorized for use during fuel system repair:

8.8.1 Buffing Band. These bands are for buffing arbors and are provided in various grits.

8.8.2 Fuel Cell Buffers. These buffers are used for heavy buffing such as removing fitting flanges, buffing self sealing cells, buffing light weight cells and finishing work on beads, etc.

8.8.3 Buffing Stone. These grindstones are used in buffing bladder cells and fitting flanges.

8.8.4 Electric Knife. This knife shall be equipped with a tungsten carbide cutting edge used for carving foam material (polyurethane).

8.8.5 Hot Knife Blade. A locally manufactured item used in fuel cells to remove fittings and trim sealants. (Ref. USAF drawing 61B25215).

8.8.6 Sealant Spatula. Sealant Spatulas are stocklisted in sets of three.

8.8.7 Stitcher Horizontal Offset. This stitcher is used in patch repair of fuel cells. The offset provides a means of stitching patches in corners. The small wheel provides the repairman close contact with stepoff areas. (See figure 8-8).

8.8.8 Roller Stitcher. This stitcher is used to apply patches in thin type cell or other areas in which a short stitcher is desired. (See figure 8-9).

8.8.9 Stitcher Vertical Offset. This stitcher is used to accomplish patch installation in confined areas. (See figure 8-10).

8.8.10 Temporary Repair Kits. Comp Air D-236 Injector Kit.

8.9 SEALING EQUIPMENT.

The following items are authorized for use when sealing fuel systems and are divided into two categories. Curing type sealing equipment, and non-curing type sealing equipment.

8.9.1 Sealant Scraper. This scraper is used to remove damaged sealant. The scraper is a non-spark producing cutting tool. Acceptable materials are plastic, wood, phonelic, or aluminum. (See figure 8-7).

8.9.2 Shot Bag. A locally manufactured bag filled with shot which is used in fuel system repair to anchor items such as air mover, air hose, etc.

8.9.3 Curing Type Sealing Equipment.

8.9.4 Cartridges, sealant containers. There are seven sizes of cartridges stock listed for Air Force use. The cartridges are stock listed with and without plungers. (See figure 8-11).

8.9.5 Kit Gun and Mixer. The kit contains a filleting and injection gun, mixer for cartridges, service wrench for filleting, 2-1/2 ounce retainer, six ounce retainer for the filleting gun, flexible hose for filleting gun, brush cap cleaner for injection gun, rod cleaner for each size nozzle and two high pressure hose extensions for the injection gun.

8.9.6 Sealant Mixer. Semkit Model 285 is approved for mixing sealant used in integral fuel tanks. This machine provides a method to economically and efficiently mix cartridges. It greatly reduces the mixing time while assuring thorough mixing. The machine provides the operator a tool to maintain consistency in mixing.

8.9.7 Filleting Nozzles. Nozzles for filleting are available through Air Force stock in various size, shapes and orifice sizes. Standard nozzles may be cut to any angle required in applying fillet. The thickness of fillet is controlled by the orifice size. (See figure 8-12).

8.9.8 Injection Nozzles. Nozzles for injection guns are available through Air Force stock in three sizes. They are 3/16, 1/8, 3/32-inch orifice.

8.9.9 Cartridge Sealant Plunger. There are two types of plungers available through Air Force stock. The 250P plunger can be used in the cartridge for filleting gun only. The 250 plunger is equipped with a removable plug that can be used with either the filleting or the injection gun.

8.9.10 Filleting Guns Retainer. The retainers are stocklisted in two sizes, 3-1/2 oz. and 6 oz. The retainer is selected for the size of cartridge to be used.

8.9.11 Cleaner for Nozzles Injection Gun Rods. The rods are stocked in the same size as the orifice for the nozzles. The cleaners are to remove clogged sealant in nozzles.

8.9.12 Sealant Gun. There are several curing type sealant guns used to apply fillet seals, adhesives and resins.

8.9.13 The following are approved curing type sealant guns:

Semco 750
Semco 850
Model 250-6

8.9.14 Non-Curing Sealing Equipment. The following is a list of approved non-curing type sealant guns:

Model 223
Model 225
Model 227
Model 507A
Model 509

8.10 MATERIALS.

The approved materials for use in fuel system repair are divided into the following categories: sealants, adhesives, cleaners/solvents, external (temporary) patch materials, fuel cell repair materials, corrosion protection materials, leak detection materials, purge fluids, fire suppressant foam, paints, and general materials. All materials listed may not be necessary to perform fuel tank repair. Consult the system peculiar technical manual or this technical manual for requirements.

NOTE

Some adhesives, sealants and cements require special storage. Refer to the stocklist, AFMAN 23-110, or manufacturer's recommendations. Attention must be paid to the shelf life and age control examination.

8.10.1 Sealants. The following types of sealants are primarily used to seal integral fuel tanks and are divided into three classifications - curing sealants, non-curing sealants and structural adhesive sealants:

8.10.1.1 Curing, Fuel Tank Sealants.

a. MIL-S-29574 Low Temperature Curing (PR-1826)

b. MIL-S-8802 for Jet Fuel Tanks

c. MIL-S-83430 High Temperature Performance

d. MIL-S-81733 Corrosion Inhibited

e. MIL-S-83318 Low Temperature Curing

f. MIL-S-8784 Low Adhesion

g. PRO-Seal 872 High Adhesion Access Door Sealant

h. PR 1403 Corrosion Inhibiting Low Adhesion Access Door Sealant

i. PR 1828 Low Temperature Curing

8.10.1.2 Non-Curing, Injection Sealants.

a. PR-702 Non-curing Rubber Based Sealant

b. Q-94-011 Non-curing Fluorosilicone Sealant

c. Q-94-031 Non-curing Fluorosilicone Sealant

d. G-651 Non-curing Cyanosilicone Sealant

e. Q4-2805 Non-curing Fluorosilicone Sealant

8.10.1.3 Structural Adhesive Sealant. AF-10 Thermosetting, nitrile phenolic

8.10.1.4 General features of these sealants are as follows:

a. MIL-S-8802 is a fuel resistant sealant. Most aircraft are sealed with this material. The sealant is cured by the addition of an accelerator to the base compound in accordance with the manufacturer's instructions. Class A material is for brush application, Class B for filleting, and Class C for faying surfaces. It is also available with varying application lives, such as 1/2 hour and two hours. A topcoat is not usually used, however, a polyurethane coating (MIL-C-83019) is recommended when uncoated cadmium is present.

b. MIL-S-83430 is similar to MIL-S-8802 except it has better high temperature performance, designed for limited service life at temperatures up to 360° F. MIL-S-83430 may be used as a substitute for MIL-S-8802 to make repairs but the reverse is not true without system manager approval.

c. MIL-S-81733 is similar to MIL-S-8802 with added chromates for corrosion inhibition. It is used in faying surfaces and for installation of fasteners.

d. MIL-S-83318 is two-part temperature (20° F minimum) curing sealant for repair of aircraft integral fuel tanks and fuel cell cavities in a cold environment. The sealing compound is a Class A consistency, suitable for brush or extrusion gun application. It cures to a fuel resistant rubber at temperatures from 20° F, upward. A primer is furnished with the material.

e. MIL-S-8784 is a two-part, low adhesion sealant for use on some faying surfaces, and gasket type seals for access doors and accessories. The sealant is colored red to distinguish it from MIL-S-8802 material. MIL-S-8784 is available in two dash numbers indicating -1/2 and -2 hours work-life. The sealant is also supplied in two viscosities, Class A (suitable for brush application) and Class B (suitable for application by spatula or filleting gun).

f. Pro-Seal 872 is a two part, high adhesion fuel resistant, electrically conductive, corrosion inhibitive sealing compound for access doors.

g. PR-1826, Class B is a two part chemically curing polythioether polymer based sealant characterized by rapid cure at low temperature to a fuel resistant elastomer. This material has application temperatures as low as 40° F. When used with PR-1826 primer, the sealant adheres to Alclad, MIL-A-8625, MIL-C-5541, Titanium, Stainless Steel MIL-C-27725, coated surfaces and MIL-C-8802 sealants. PR-1826 Primer will promote adhesion of PR-1826, Class B to itself and to materials and treatments commonly used for aircraft fasteners.

h. PR702 is a non-curing one part synthetic rubber based sealant which does not harden and remains flexible. It is "semi-fluid"which allows "old" sealant to be flushed from sealant grooves/channels during leak repair efforts. It is common to the A-7 aircraft.

i. Q-94-011 and Q-94-031 are non-curing one-part fluorosilicone based sealants which do not harden and remain flexible. Q-94-031 is the same as Q-94-011 but contains plastic beads which pile up at leakage points and tends to be better for sealing leaks. Color is white or light gray and is a“semi-fluid” material.

j. G-651 is a non-curing one-part cyanosilicone based sealant. It contains beads like Q94-031. The color is yellow.

k. Structural adhesive AF-10 is a thermo-setting adhesive which requires an approved oven to cure the material. The adhesive is used for faying surface sealing in some integral tank designs. If damaged in service, it is repaired by fillet overcoat of MIL-S-8802 or MIL-S-83430.

8.10.2 Adhesives/Cements. The following are adhesives/cements approved for use as stated in applicable chapters of this technical manual:

a. Adhesive, for Fuel Cells, MIL-A-9117.

b. Adhesive, Heat Vulcanizing.

c. Adhesive, MIL-A-46050.

d. Cement, Hot or Cold Bonding, MIL-S-13883.

e. Cement, MMM-A-122.

f. Cement, two part 5923C.

g. Adhesion Promoter, PR-148.

8.10.3 Cleaners/Solvents. The following is a list of approved cleaners and solvents for fuel system repair. Refer to integral tank or fuel cell chapter for detailed use.

a. Acetone.

b. Alcohol, Ethyl, MIL-A-6091.

c. Alcohol, Isopropyl, TT-I-735.

d. Cleaner Compound, MIL-C-87936.

e. Cleaning Solvent, MIL-C-38736.

f. Ethyl-Acetate, TT-B-751.

g. Methyl Ethyl Ketone (MEK), TT-M-261.

h. Methyl Isobutyl Ketone (MIBK), TT-M-268.

i. Toluene, TT-T-545.

j. Desealant Type I, Class B, MIL-D-9063.

k. Naphta, TT-N-95.

8.10.4 External (Temporary) Patch Material. The following is a list of approved patch materials for making temporary repairs. See applicable chapter of text for proper repair procedure and material use.

a. Hardman Fast Setting Adhesive.

b. Epoxy Tabs Type O.

c. Aluminum Foil 0.0015, 0.0020 inch.

d. Aluminum Stock 2020ST, Aluminum Stock 5052.

e. Pressure Sensitive Aluminum Tape.

f. Loctite Sealant, Grade A, MIL-S-22473.

g. Oyltite Stik.

h. Cellophane, Clear 6-inch Wide.

8.10.5 Fuel Cell Repair Material. The following is a list of approved patch material for fuel cells: (For proper use and applications refer to chapter on fuel cell repair.)

a. BUNA-N (Nitrile) Sandwich Material.

b. BUNA-Nylon Nitrile Sandwich Material

c. Cloth, Laminated 2 Ply, Nylon.

d. Epoxy Patching Compound.

e. Fabric, Sheet Nylon Sandwich.

f. Nylon, Liquid Blue, Goodyear 5073C.

g. Nylon, Liquid Yellow, Goodyear 5074C.

h. Sheet, BUNA-N (Nitrile) 0.035 inch.

i. Sheet, Sealant Gum (Self-Sealing Cell).

j. Sheet, Sq, Cloth Coated 0.020 inch thick.

8.10.6 Corrosion Protection. Approved materials for corrosion protection are as follows: (Refer to proper chapter for application and uses.)

a. Conversion Coating, MIL-C-81706.

b. Coating, Corrosion Protection, MIL-S-4383 (BUNA-N).

8.10.7 Leak Detection Material.

a. Ammonium Hydroxide, O-A-491.

b. Bulb, replacement type, Black Light.

c. Dye, Liquid, Red, MIL-D-81298.

d. Dye, Liquid, Yellow.

e. Phenolphthalien.

f. Powder, Dyed Red Talcum.

g. Soap, Bubble Solution non-corrosive, MIL-L-25567.

h. Soap Suds Test.

i. Zyglo ZL-22.

j. Widger WC-4700.

8.10.8 Purge Fluids. Approved purge fluids are as follows:

a. Purge Fluid per specification MIL-F-38299.

b. JP-8 Fuel.

c. JP-5 Fuel, MIL-T-5624.

8.10.9 Fire Suppressant Foam.

8.10.9.1 Black felt tip marker for identifying replacement foam baffles. Blaisdell liquid tip No. 1173-F, Blaisdell Pencil Co., Bathayres, PA, or equivalent.

8.10.9.2 Foam buns, MIL-B-83054, standard bun sizes include:

a. Yellow Type II and Dark Blue Type IV.

(1) 40 x 80 x 8 inch bun

(2) 44 x 110 x 12 inch bun

(3) 44 x 110 x 8 inch bun

b. Red Type III and Light Blue Type V

(1) 44 x 110 x 8 inch bun

(2) 44 x 110 x 12 inch bun

8.10.9.3 Foam buns, MIL-F-87260, standard bun sizes include 8 and 12 inch widths

8.10.10 Coatings. The following is a list of approved coatings: (Refer to proper chapter for correct use).

a. Paint, Buna Vinylite Lacquer.

b. Paint (White for Stenciling), TT-C-50.

c. Coating, Polyurethane, MIL-C-83019.

d. Primer, Metal.

e. TY-PLY "N" Primer.

f. Buna-N (Nitrile) Integral Tank Coating MIL-S-4383.

8.10.11 General Materials. The following is a list of approved materials used in various fuel system repairs: (Refer to proper chapter for correct use).

a. Brush, Acid, Swabbing, H-D-643.

b. Brush, Aluminum.

c. Brush, H-B-451.

d. Brush, Camel Hair.

e. Brush, Ox Ear Hair.

f. Brush, Stiff Bristles, H-B-328.

g. Brush, Squirrel Tail Hair.

h. Brush, Varnish, H-B-695.

i. Cheesecloth, Bleach, MIL-C-87962, Type I.

j. Cleaner Soap (Floor Dock).

k. Cloth, Cotton Bunting (Wiping), CCC-C-439.

l. Cloth, Emery.

m. Cloth, Holland, White, 1 inch wide, MIL-C-17564.

n. Cloth, Laminated.

o. Cord, Nylon Type III, 500 yd., MIL-C-5040.

p. Crayon Marking Yellow.

q. Cream, Hand Cleaner Type I, P-H-31.

r. Cup, Paper, UU-C-834.

s. Detergent, 1 gal, MIL-D-16791.

t. Ethylene Glycol, MIL-E-9500.

u. Gauze Pads, MIL-C-87962, Type II.

v. Glycerine USP, MIL-O-491.

w. Kaydry Towels.

x. Lubricating Oil, VV-L-825.

y. Paper, Kraft, UU-P-268.

z. Petrolatum Type A, Class 2, VV-P-236.

aa. Plastic Bags and film, MIL-B-81705.

ab. Protective Skin Cream.

ac. Skin Protective Compound, PS-411, Type I.

ad. Soap (for Cell Cleaning) P-S-560.

ae. Sponge, Cellulose, L-S-00626.

af. Steel, Round Rod.

ag. Tape, Waterproof, 1 inch wide, PPP-T-60.

ah. Tape, Masking 2 inches wide, PPP-T-42.

ai. Tongue Depressor.

aj. Type I Cord Assembly.

ak. Water, Distilled, O-B-41.

al. Zinc Chromate Putty, MIL-P-8116.

am. Cellulose Sponge.

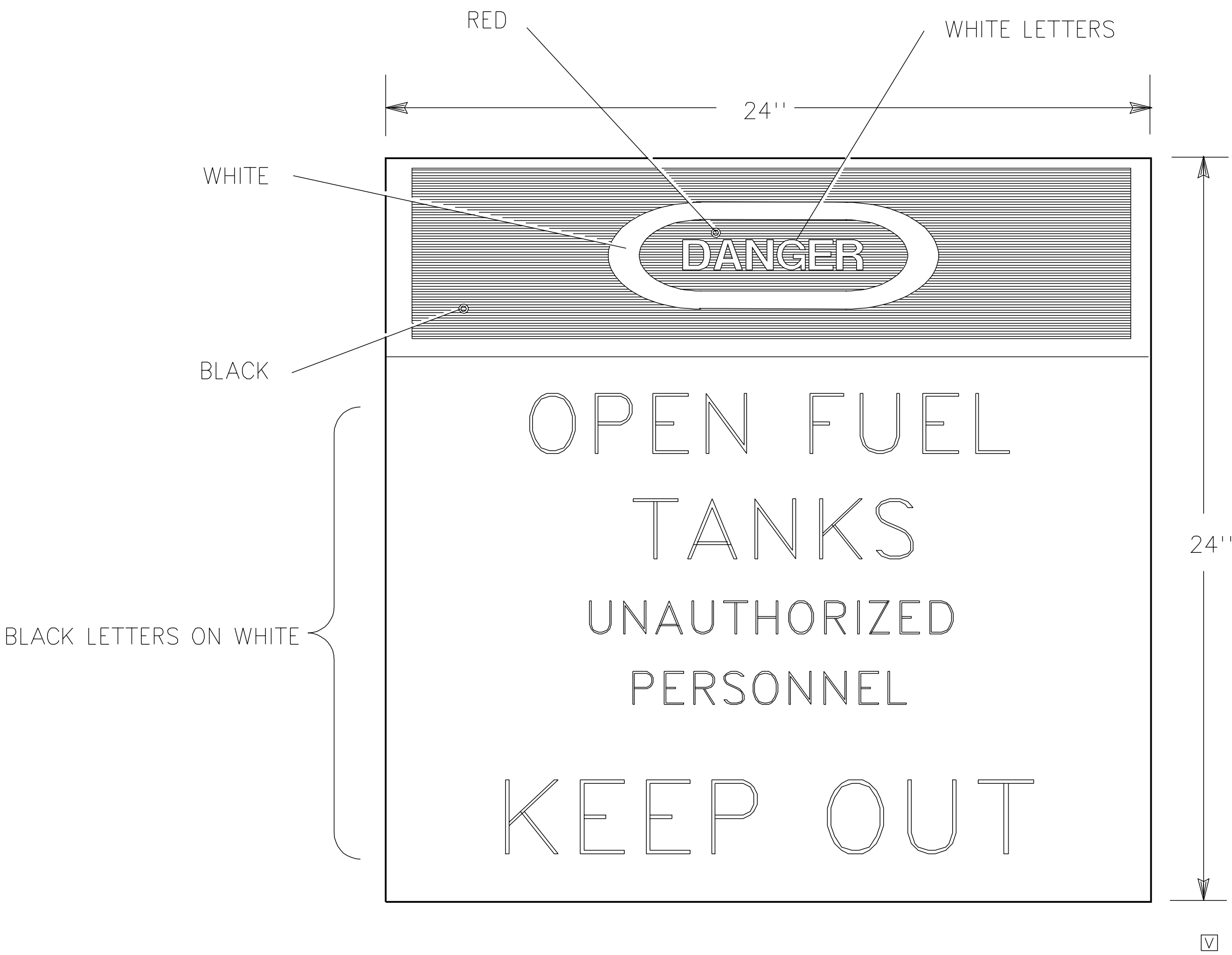


Figure 8-1. Marking of Fuel System Repair Area

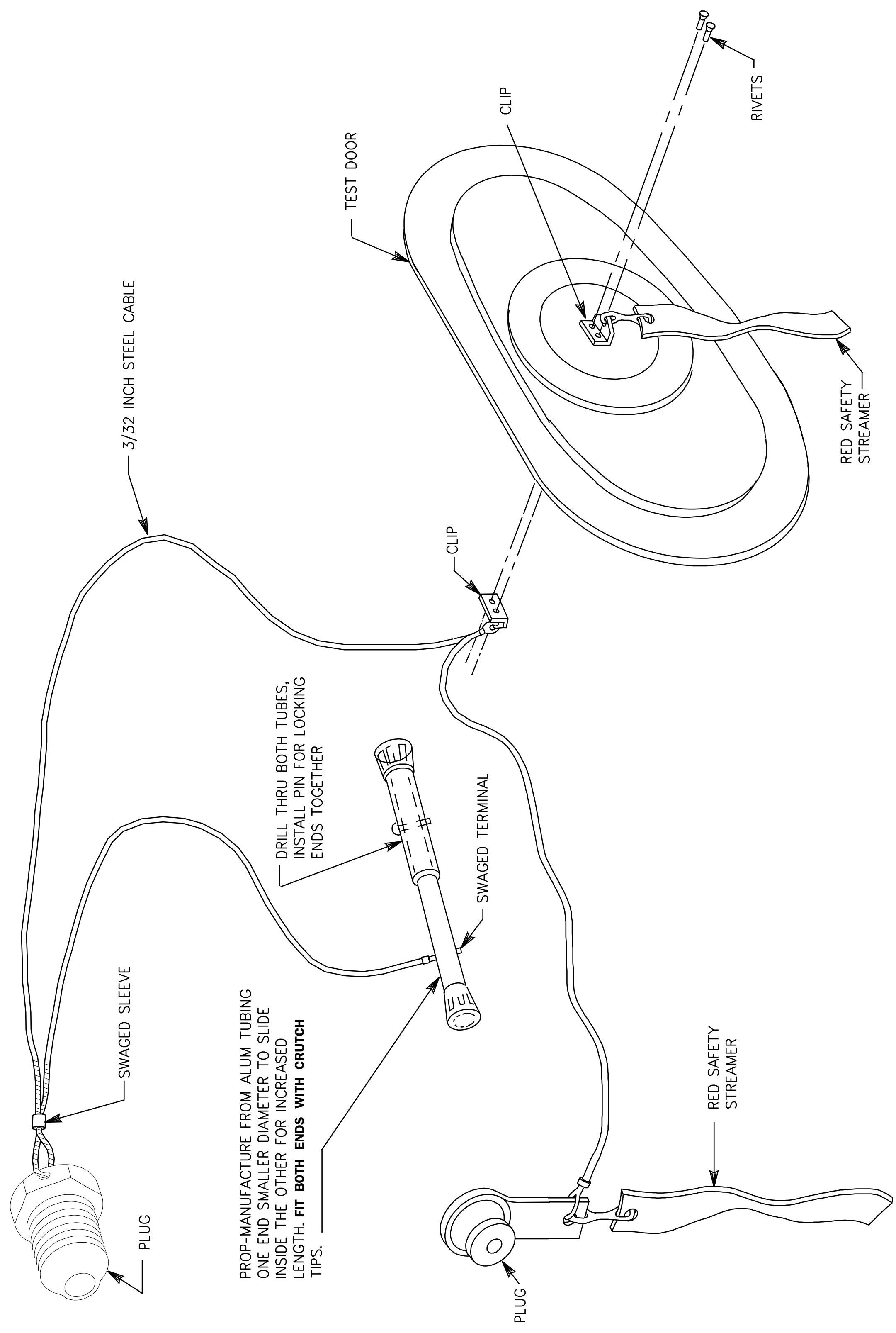


Figure 8-2. Safety Streamers for Test/Support Equipment

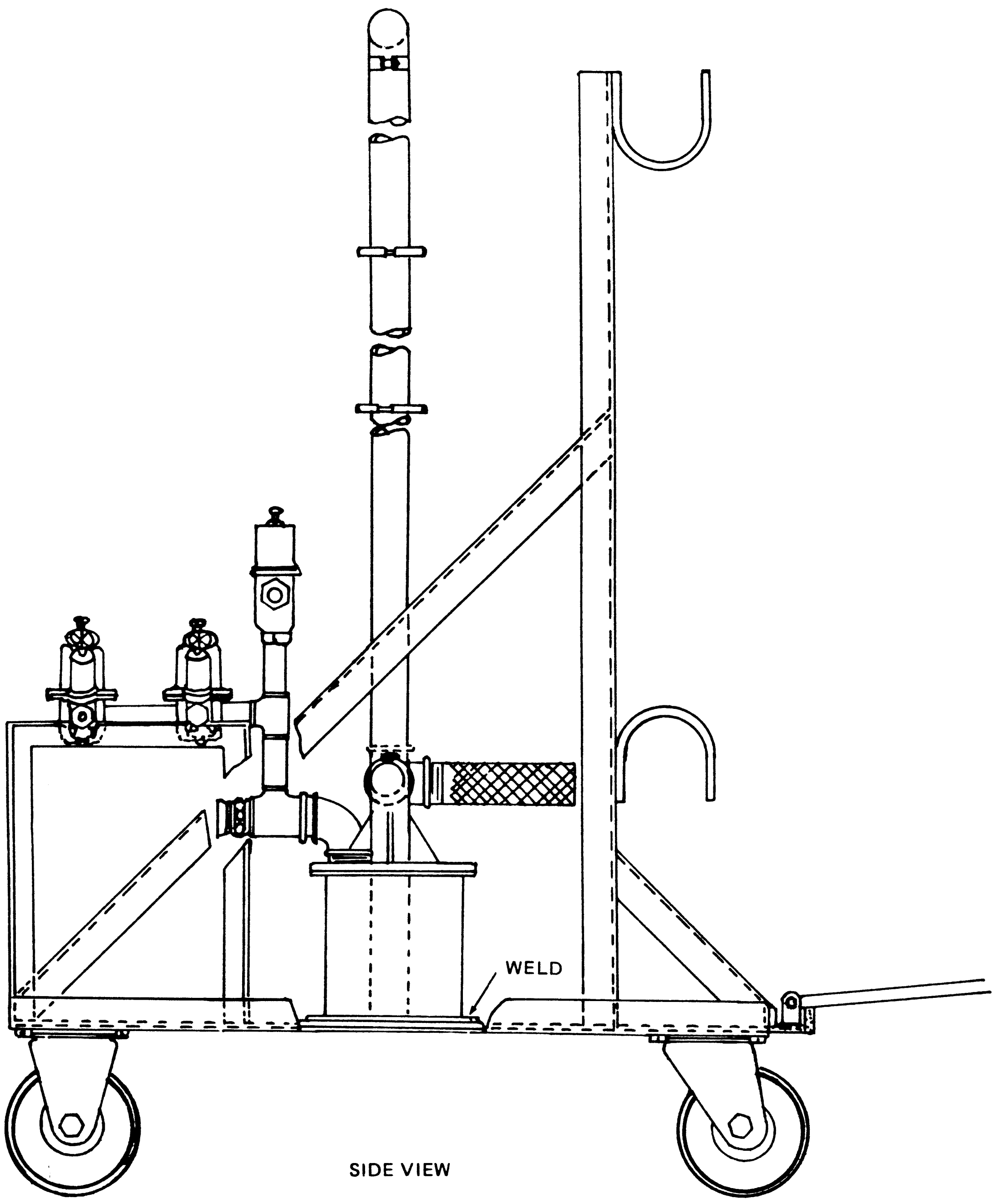


Figure 8-3. Manometer, Water 68E36424 (Sheet 1 of 2)

MANOMETER, PRESSURE
65D47338

QTY REQD	NOMENCLATURE	MFG. CODE	IDENTIFICATION NUMBER
1	RESERVOIR	98752	65C47335
1	GASKET	98752	65B47328
1	TOP PLATE	98752	65C47336
1	SUPPORT ASSY.	98752	65B47327
1	STAND PIPE	98752	65C47337
1	PIPE EXTENSION	98752	65B47326
6	GUSSET	98752	65B47325
4	BRACKET	98752	65B47334
1	PLUG	98752	65B47323
1	WASHER	98752	65B47324
4	BOLT		AN3-44
10	BOLT		AN10-15
6	NUT		AN315-3
2	CLAMP		AN755-38
2	SCREW		AN520-10-8
10	NUT		AN325-10
10	WASHER		AN935-1016
2	ELBOW	14959	2" STD, 90" SCREWED COML B.I.P.
1	TEE	14959	2X1X2 COML B.I.P.
3	NIPPLE	14959	2" STD CLOSE COML B.I.P.
1	ADAPTER	94559	M6189 COML
1	DAIRY TUBE		2" DIA. N1 1/8 WALL COML △A PLASTIC TUBE

DOLLY ASSEMBLY
PRESSURE TEST
68E36424

QTY REQD	NOMENCLATURE	MFG. CODE	IDENTIFICATION NUMBER
1	PRESSURE MANOMETER	98752	65D47338
2	CASTER		MS24380-8RU
2	CASTER		MS24380-8SU
2	VALVE	14959	1610 1/2 "Y" PATTERN DIAPHRAGM
1	VALVE	14959	2551 1" POP SAFETY VALVE SET AT 4 PSI RANGE 0 TO 30 PSI
	REGULATOR	43990	20AJ-X4GG DISCHARGE PRESSURE SET AT 3 PSI RANGE 0 TO 30 PSI
	REGULATOR	43990	20AJ-X4GG DISCHARGE PRESSURE SET AT 3.5 PSI
1	SOCKET	93064	DC-060
1	TEE	14959	1X1X1 BLACK IRON
1	TEE	14959	1X1/2X1/2
3	NIPPLE	14959	1 STD
5	NIPPLE	14959	1/2 STD
1	ELBOW	14959	1/2-90° STD
1	FRAME		67-SKA-E-142
1	TONGUE	98752	X64D45550
6	CLIP	98752	X64B45551
16	BOLT		AN8-13
3	BOLT		AN6-21
16	NUT		AN325-8
3	NUT		AN345-16
16	WASHER		AN935-816
3	WASHER		AN935-616
2	U-BOLT		SEE DETAIL
4	NUT		MS51967-2
4	WASHER		AN935-416

Figure 8-3. Manometer, Water 68E36424 (Sheet 2)

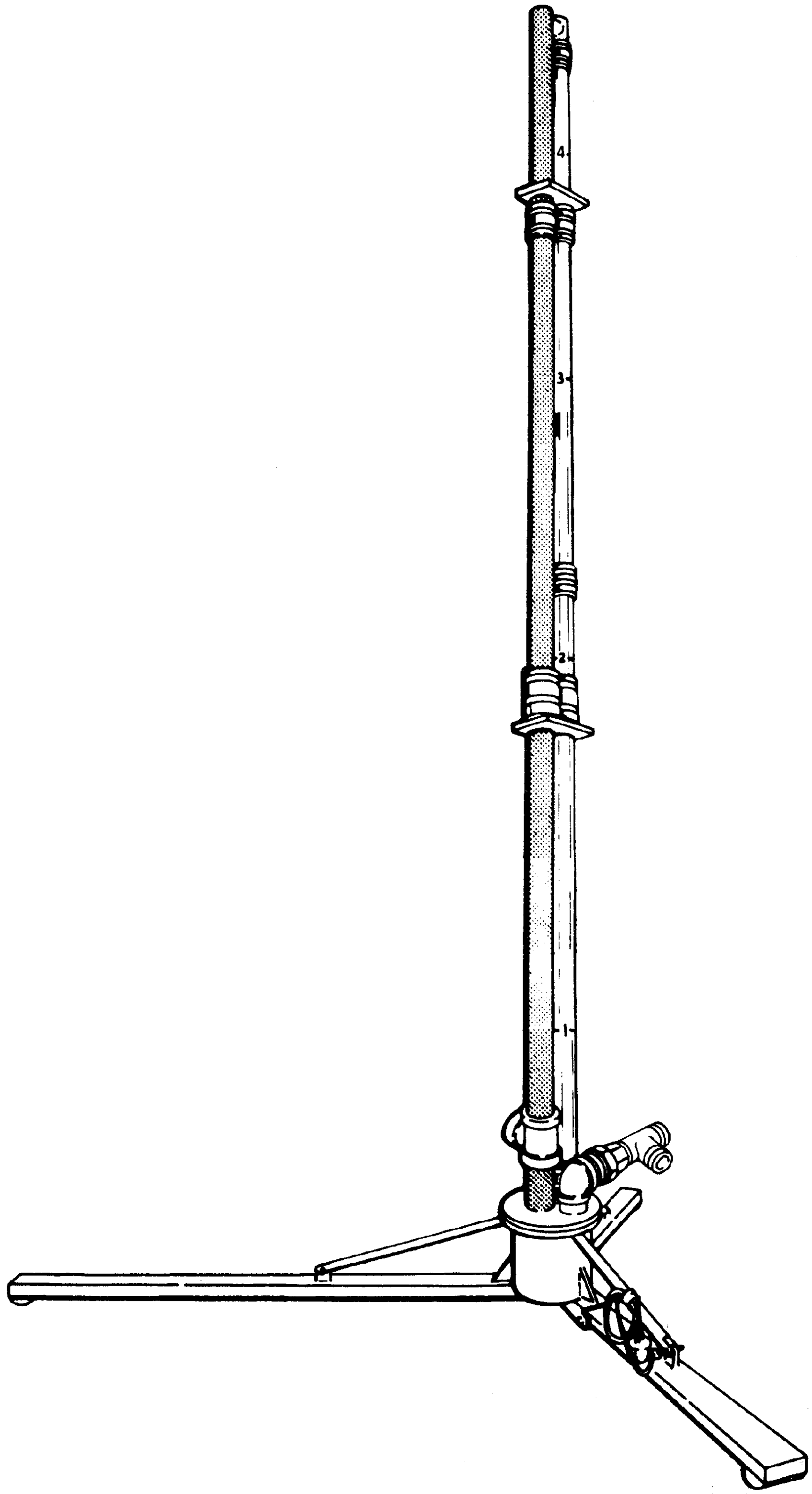
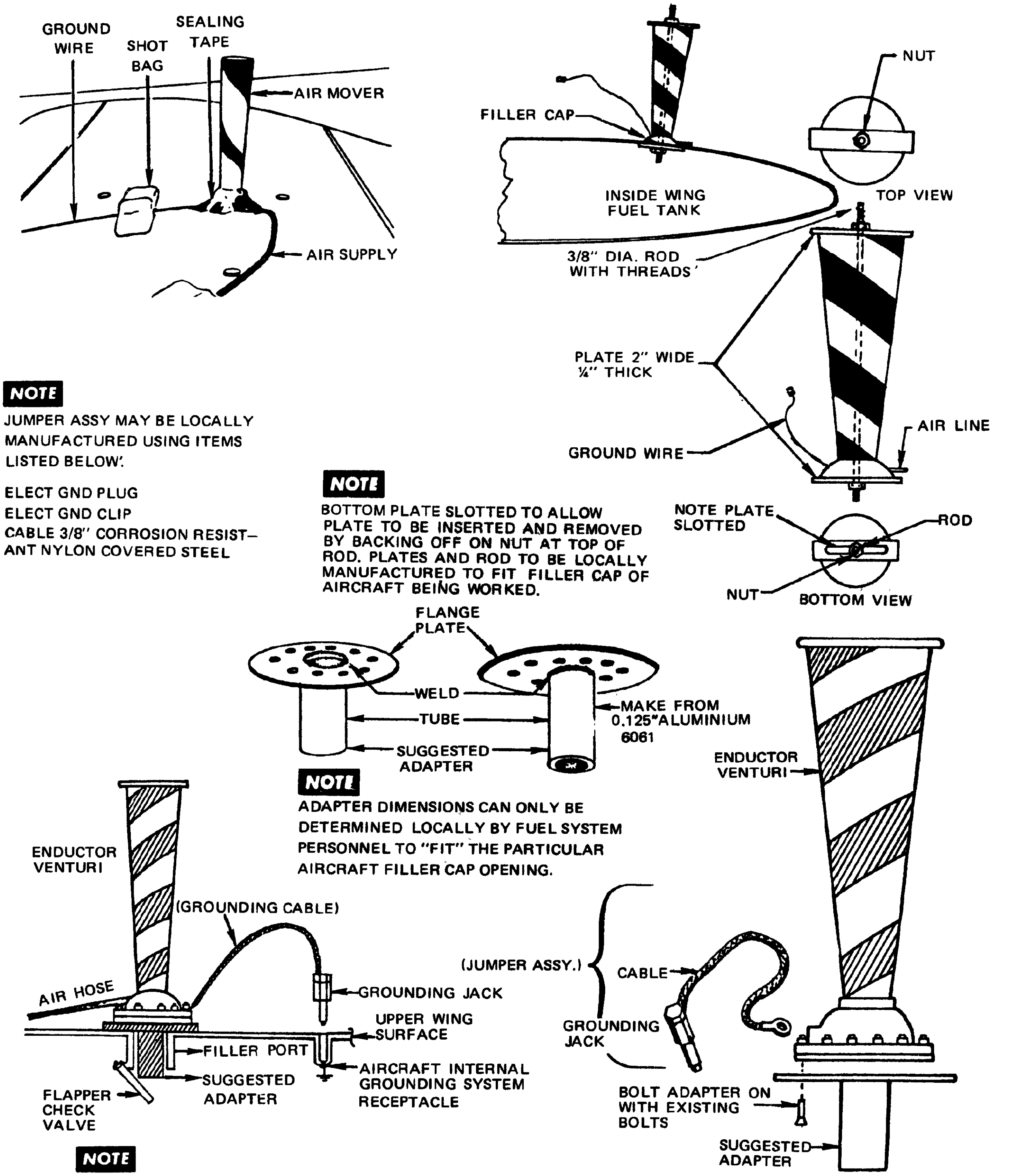


Figure 8-4. Manometer, Water F52828-116



NOTE

QUICK DISCONNECTS, FITTINGS AND CONTROL VALVES MAY BE USED ON AIR MOVER SUPPLY LINES. HOWEVER, THE QUICK DISCONNECTS, FITTINGS AND CONTROL VALVES SHALL BE NIOSH APPROVED AND MUST BE INCOMPATIBLE WITH OUTLETS FOR OTHER GAS SYSTEMS TO PREVENT INADVERTENT SERVICING OF AIR LINE RESPIRATORS WITH NON-RESPIRABLE GASES OR OXYGEN.

L8904293

Figure 8-5. Air Mover

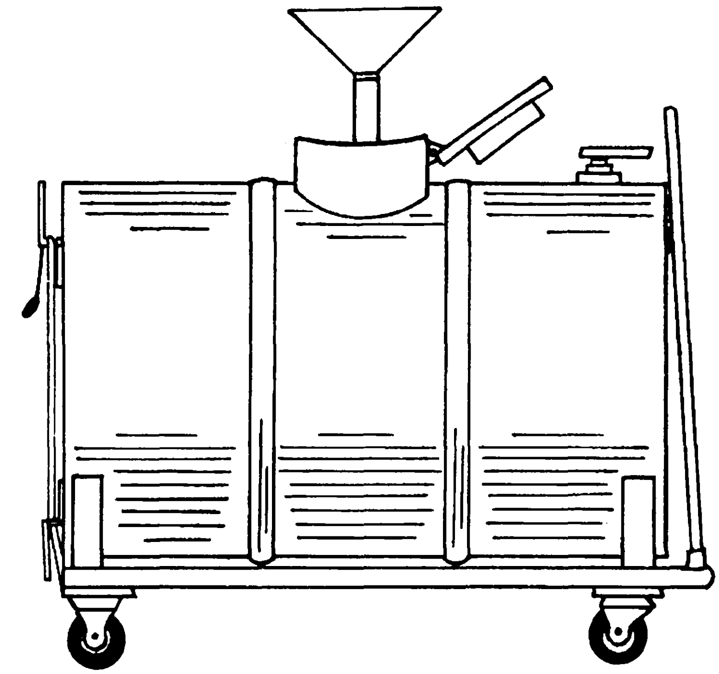


Figure 8-6. Container Drum Horizontal

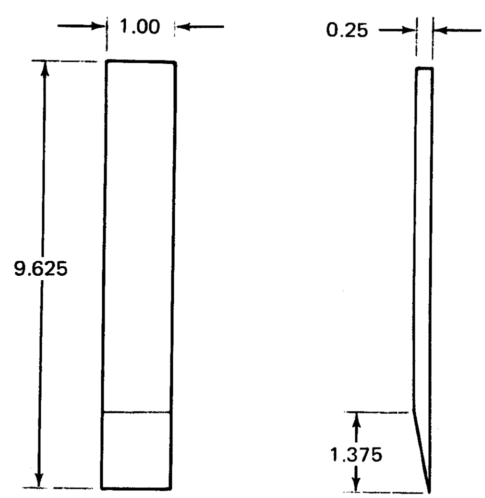


Figure 8-7. Typical Hand Scraper

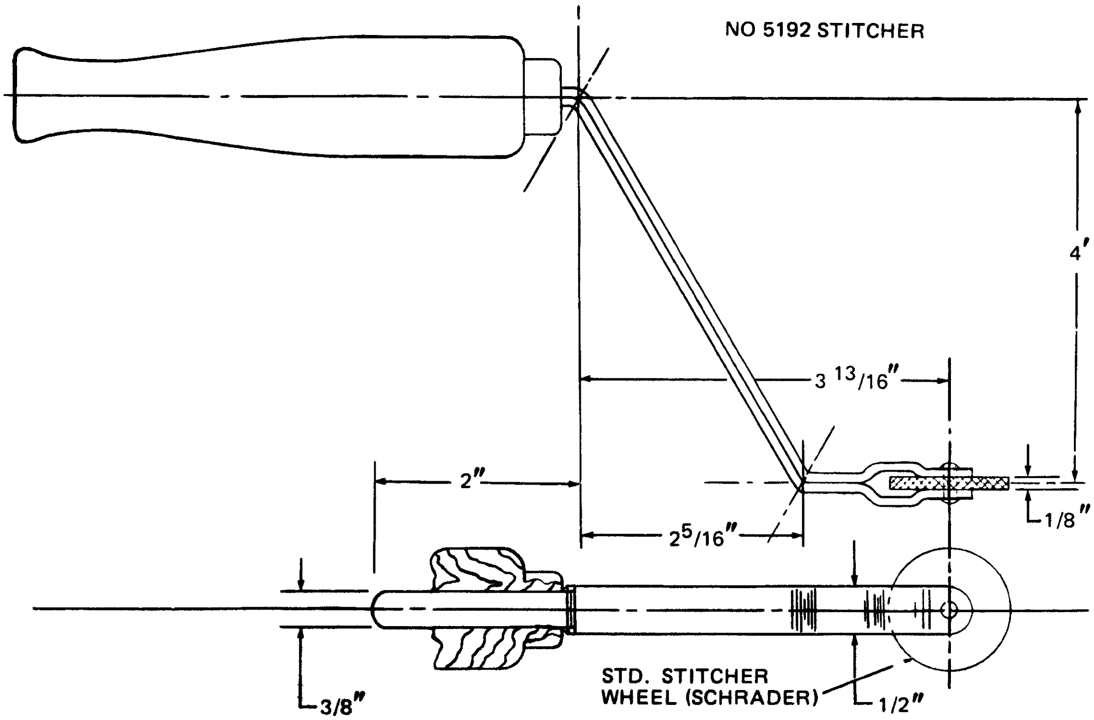


Figure 8-8. Stitcher Horizontal Offset

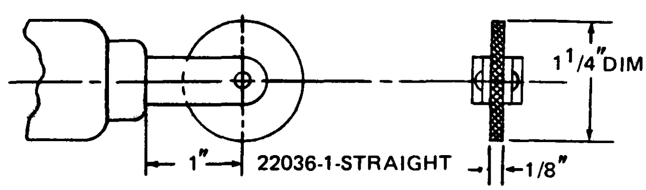


Figure 8-9. Stitcher Roller

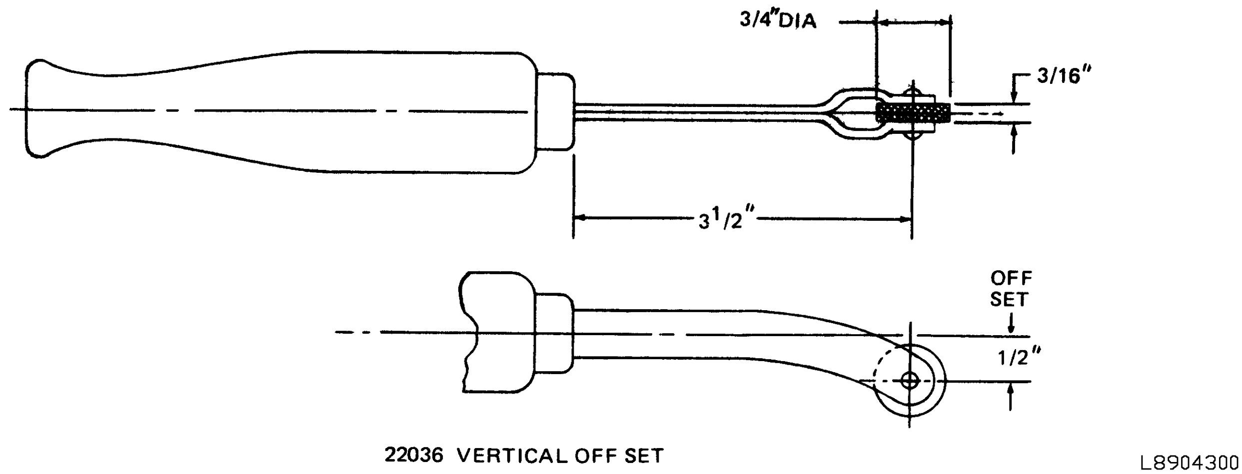


Figure 8-10. Stitcher Vertical Offset

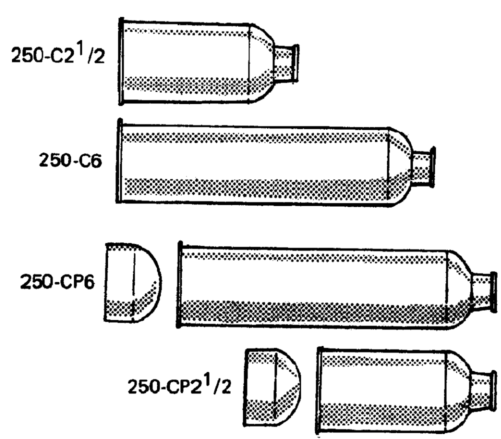


Figure 8-11. Cartridges Sealant

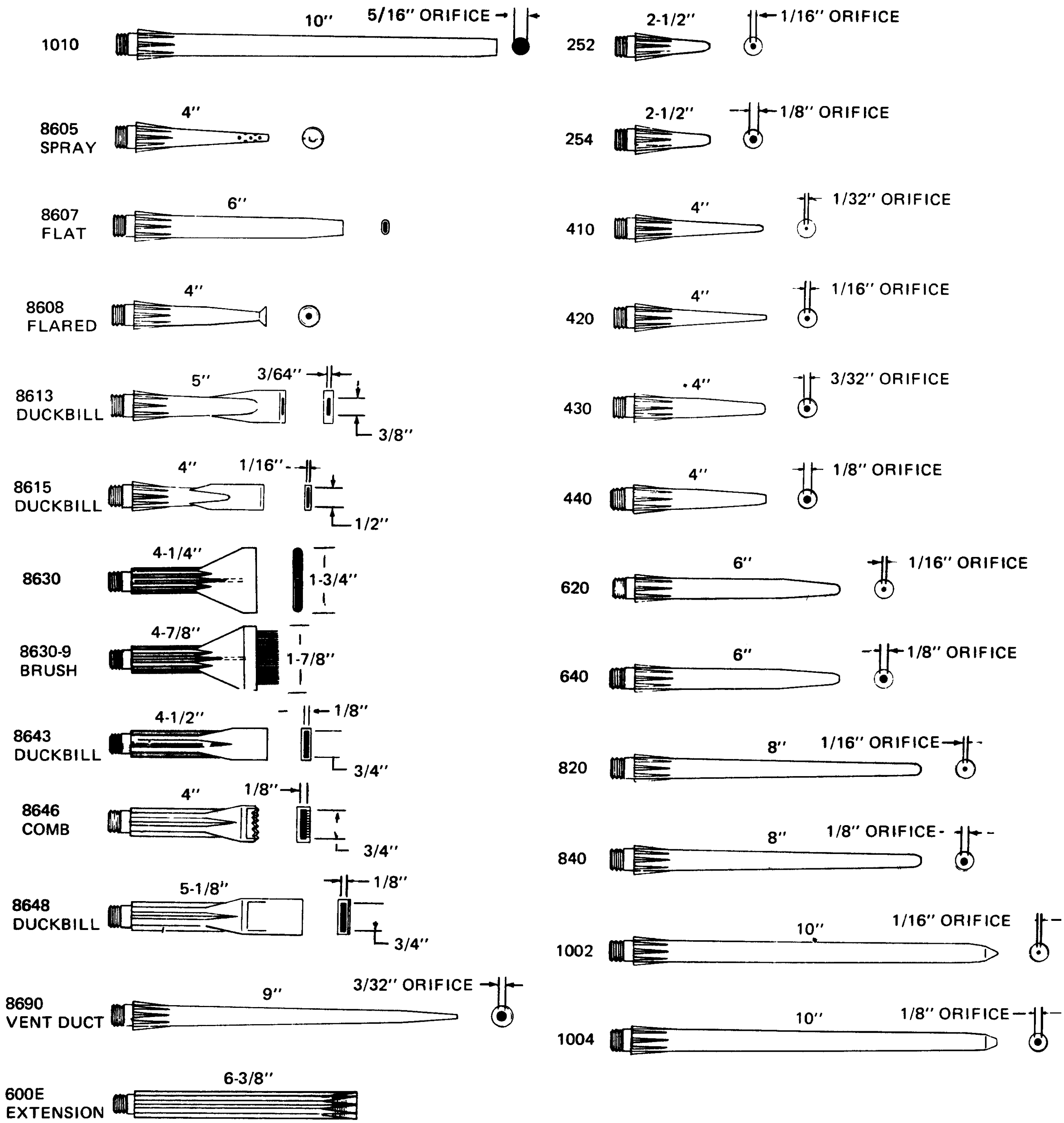


Figure 8-12. Nozzle Filleting

3 GUN MODELS

*50-2-1/2	2-1/2 OZ CAPACITY
250-6	6 OZ CAPACITY
250-12	12 OZ CAPACITY

ALL PARTS INTERCHANGEABLE

NOTE

1. PLASTIC CARTRIDGE AND STEEL SAFETY RETAINER DETERMINES CAPACITY. ALL OTHER PARTS ARE IDENTICAL.
2. TOTAL WEIGHT (6 FL OZ GUN) -15 OZ.
3. LENGTH OVERALL LESS NOZZLE (6 OZ GUN) -8-1/2.
4. PISTOL GRIP HANDLE MAY BE REMOVED TO CONVERT TO LEVER THROTTLE FOR CONFINED AREAS.

*5. 2-1/2 OZ CAPACITY RECOMMENDED FOR MOST FIELD REPAIRS.

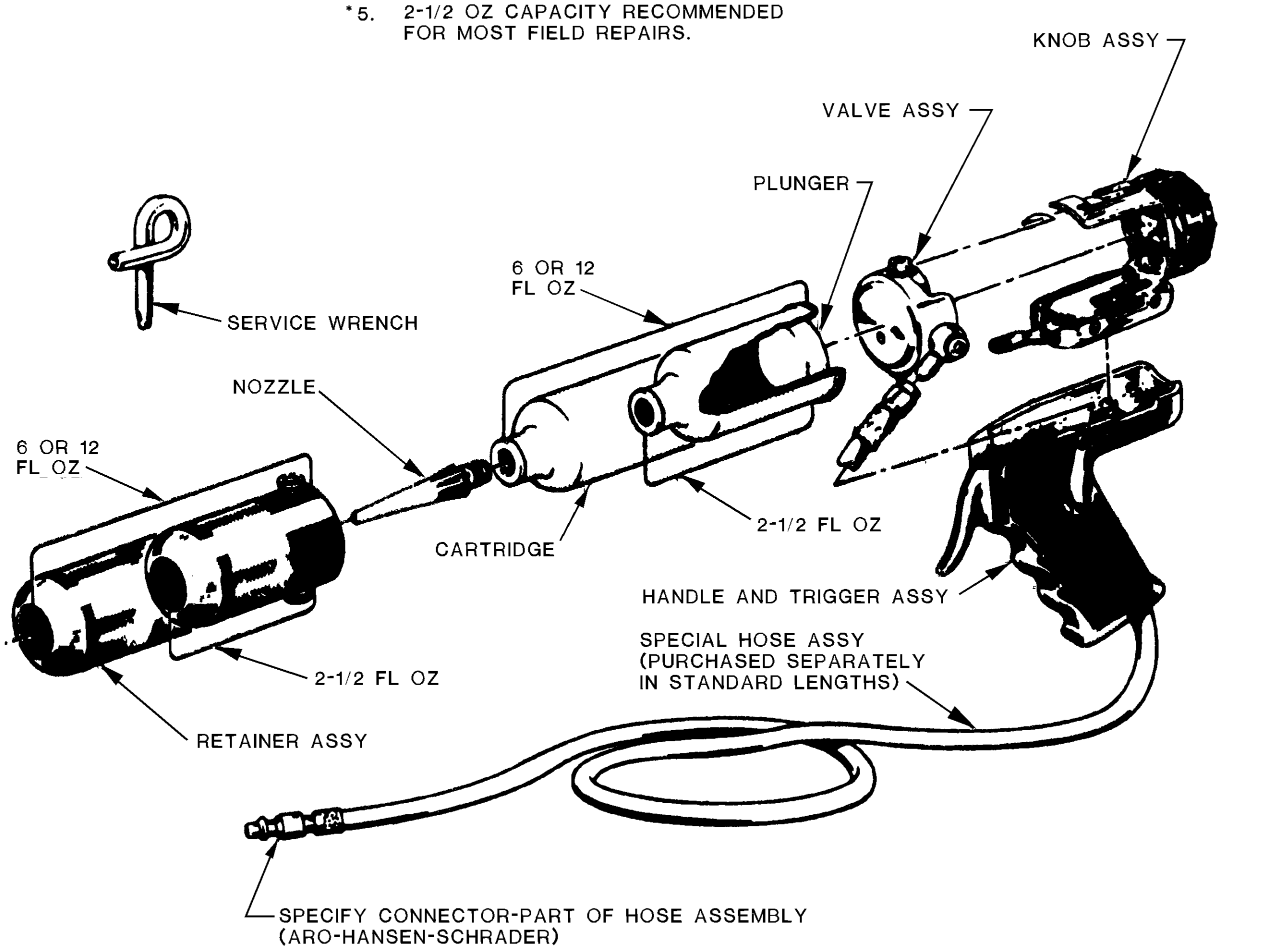


Figure 8-13. Filleting Gun

Table 8-1. Materials and Equipment

ADHESION PROMOTER CHLORIMATED	PR-147	8030-01-093-5383	PT	INCREASE ADHESION OF SEALANTS	GSA	
ADHESIVE PROMOTER AEROSOL	PRO SEAL 152 PRO SEAL 151	8030-01-132-0235 8030-01-131-3228	CN CN	INCREASE ADHESION OF SEALANTS	GSA GSA	16 OUNCES 16 OUNCES
ADHESIVE PROMOTER, NON-CHLORIMATED	PR-148	8030-00-560-8755	PT	INCREASE ADHESION OF SEALANTS	GSA	
ADHESIVE, HEAT VULCANIZING	1895C LP729	8040-01-280-5520 8040-00-200-6415	KT KT	CELL REPAIR	GSA GSA	PINT QUART
ADHESIVE, HOT OR COLD BONDING	MMM-A-189, CLASS 2	8040-00-543-7171	PT	NITRILE CELL REPAIR	GSA	
ADHESIVE, PHOECEL	5071C	8040-00-390-5606	KT	REPAIR OF PHOECEL FUEL CELLS	GSA	1 QUART
ADHESIVE, ROOM TEMPERATURE CURE	MIL-A-9117 MIL-A-9117, CLASS L	8040-00-262-9060 8040-00-266-0389 8040-00-576-1781	QT PT BT	NITRILE CELL REPAIR	GSA GSA GSA	2 OUNCES
ADHESIVE, ROOM TEMPERATURE CURING	MIL-A-46050 EASTMAN 910	8040-00-142-9193	PT	CELL REPAIR	GSA	
ADHESIVE, VITHANE	82C32	8040-01-234-6624	KT	FUEL CELL REPAIR	GSA	1/2 PINT
AIR COMPRESSOR	MC-1A MB-1 (ELECTRIC) MC-7		EA EA EA	PROVIDE AIR TO OPERATE EQUIPMENT, TOOLS, REFER TO STOCKLIST FOR NSN.	FLZ FLZ FLZ	
AIR CONDITIONER	A/M23C-4 (ELECTRIC) AM32C-5 (ELECTRIC) A-3 (GASOLINE) MA-1, MA-3 SERIES A/M32-10 SERIES		EA EA EA	CLIMATE CONTROL AND VENTILATION OF AIRCRAFT AND FACILITIES, REFER TO STOCKLIST FOR NSN.	FLZ FLZ FLZ	7 TON 11.5 TON 7 TON
AIR PURIFIER CART				REFER TO STOCKLIST FOR NSN		

Table 8-1. Materials and Equipment - Continued

ALCOHOL	0E760 (DENATURED) TT-1-735 (ISOPRO-PYL)	6810-00-201-0907 6810-00-855-6160	CN CN	GENERAL PURPOSE SOLVENT	S9G S9G	5 GALLON 5 GALLON
ALUMINUM FOIL	11-A-1876	9535-00-242-5661 9535-00-249-5785 9535-00-273-1815	RO RO RO	USED FOR EXTERNAL PATCHES ON FUEL TANKS	S9I S9I S9I	0.0015 0.0010 0.0020
ALUMINUM STOCK	QQ-A-225/6 (2020ST) QQ-A-225/7 (5052)	9530-00-236-1379 9530-00-236-0308	FT FT		S9I S9I	10’ X 1.5″ 10’X 1.5″
AMMONIUM HYDROX-IDE	0-A-451	6810-00-222-9643	BT	LEAK TESTING FUEL CELLS	S9G	80 OUNCE
ANTISTATIC ADDITIVE	ASA-3	6850-01-064-6510	GL	ADDITIVE FOR MIL-SPEC PURGE	S9G	FLUID
BAG, ELECTROSTATIC FREE	MIL-B-117	8105-01-268-4413 8105-01-268-4414	BX 50 EA	PACKAGING FOAM MA-TERIAL	GSA	56″ X 36″ 48″ X 48″
BLOWER FILTER AS-SEMBLY	60D90327 (CAGE 98750)			LOCAL MANUFACTURE		
BLOWER, PNEUMATIC OPERATE	NF17-8	4140-01-105-6326	EA	VENTILATING AND PURGING FUEL TANKS	S9G	8-INCH 1600 CEM
BRUSH	H-B-451	8020-00-721-9646	EA	USED TO APPLY MIL-C-27725 AND OTHER COMPOUNDS	GSA	1″ WIDE
BRUSH	H-B-118 (OX HAIR) H-B-391 (GOAT HAIR) H-B-420 VARNISH)	8020-00-224-8006 8020-00-224-8010 8020-00-205-1306 8020-00-260-1306 -	EA EA EA EA	ADHESIVE AND CE-MENT APPLICATION	GSA GSA GSA GSA	3/8″ WIDE 1″ WIDE 1.5″ WIDE 1″ WIDE
BRUSH, SCRUB (STIFF BRISTLE)	H-B-1490	7920-00-619-9162	EA	GENERAL PURPOSE	GSA	1.75″X4.5″
BUFFING STONE				BUFF CELL SURFACES PRIOR TO APPLICA-TION OF ADHESIVE, DRESS PATCHES AFTER PATCH APPLICATION OR BUFF FITTING FLANGES		3 INCH 7 INCH

Table 8-1. Materials and Equipment - Continued

BUNA-N NYLON SANDWICH MATERIAL	5200-5187	8305-00-396-1035	YD	PATCH MATERIAL FOR FUEL CELLS	S9G	40 INCH
BUNA-N SANDWICH MATERIAL	PF 10056	9320-00-291-8468	SH	PATCH MATERIAL FOR FUEL CELLS	S9G	36″ X 36″
BUNA-N TOP COAT (NITRILE)	MIL-S-4383	8030-00-664-4019 8030-00-664-4954 8030-00-857-3604	PT QT GL	TOP COAT FOR BUNA-N PATCHES	GSA GSA GSA	
BUFFER, FUEL CELL				USED FOR HEAVY BUFFING SUCH AS THE REMOVAL OF FLANGES, OR FINISHED WORK ON BEADS		
CART, FUEL CELL SERVICING	92103000	1740-01-326-0421	EA		FPZ	
CELLOPHANE, CLEAR	A-A-1742	8135-00-721-9878	RO		GSA	6800 X13″
CEMENT, VITHANE	5923C	8040-00-518-3455	KT	VITHANE CELL REPAIR	GSA	1/2 PT
CLEANING COMPOUND	MIL-C-87936, TY 1	6850-00-935-0996	CN	GENERAL PURPOSE AIRCRAFT CLEANER	GSA	5 GALLONS
CLEANING COMPOUND	P-C-435 A-A 1992	7930-00-531-7847	CN	CLEANING FUEL DOCK FLOOR	GSA	25 POUNDS
CLEANING SOLVENT	P-D-680, TYPE I TYPE II TYPE III MIL-C-87937, TYPE I TYPE II			CLEANING FUEL TANKS. REFER TO STOCKLIST		
CLICK PATCH	231232 232155 2321546 231230	8040-01-107-3977 8040-01-107-3980 8040-01-107-3981 8040-01-107-4932 -	KT KT KT KT	FUEL TANK REPAIR	GSA GSA GSA GSA	HAT SHAPE FLAT, HEAT FLAT HAT SHAPE
CLOTH, CLEANING	RYMPLE 301 CCC-C-46, TY 1, CL 7	7920-01-004-7847 7920-01-180-0556	RO BX	CELL AND TANK CLEANING	GSA GSA	
CLOTH, COTTON BUNTING	CCC-C-439	8305-00-286-5050	YD	GENERAL PURPOSE CLEANING	S9T	12″ WIDE
CLOTH, EMERY	P-C-439			REPAIR OF FITTINGS, REFER TO STOCKLIST		

Table 8-1. Materials and Equipment - Continued

CLOTH, HOLLAND, WHITE	MIL-C-17564	8305-00-361-4921	YD	USED FOR FUEL CELL REPAIR	S9T	1″ WIDE
COAT, COLD WEATHER	MIL-C-43455	8415-00-782-2936 8415-00-782-2939 8415-00-782-2942	EA EA EA	APPROVED OUTER GARMENT	S9T S9T S9T	SMALL MEDIUM LARGE
COATING, CORROSION CONTROL (ALODINE)	MIL-C-81706	8030-00-811-3723	BT	CORROSION PREVENTIVE FOR METAL/ALUMINUM SURFACES	GSA	2 POUNDS
COATING, CORROSION PROTECTION	MIL-C-27725, TY-2, CLB	8030-00-062-8449	KT	CORROSION PROTECTION FOR METAL SURFACES	GSA	GALLON
COMBUSTIBLE GAS AND OXYGEN INDICATOR	009-3001-01N	6665-01-457-0472	EA	TEST AND MONITOR OXYGEN AND FUEL VAPORS IN FUEL TANKS (PPM)	FPZ	
CONDUCTIVITY METER	1152	6630-01-115-2398	EA	TEST CONDUCTIVITY OF PURGE FLUID	FPZ	
CONVERSATION COATING	MIL-C-81706 CHEMICAL KIT 120	8030-00-613-3131 8030-00-779-4699	KT	TREATMENT OF EXPOSED METAL AND ALUMINUM	GSA GSA	4 OUNCE
CORD, NYLON	MIL-C-5040, TYPE III	4020-00-240-2146	SP	GENERAL PURPOSE AND FUEL CELL INSTALLATION	GSA	700 YARDS
COVER, FOOTWEAR	NEO-SOCK		PR	LOCAL PURCHASE		1 PAIR
CRAYON, MARKING	A-A-2360 TYPE 1 SIZE B	7510-00-281-1731	BX	GENERAL PURPOSE	GSA	8 ASSORTED COLORS
CUP, PAPER	UU-C-806	7350-00-290-0588	BX	MIXING ADHESIVE	GSA	1200 EA
CLEANER, VACUUM PNEUMATIC	55-20 55-IAS	7910-00-632-9840	EA	DEPUDDLING TANKS AND DEBRIS REMOVAL	GSA	25 CFM
CONTROL BOX, LEAK TRACING DEVICE				USED WITH VACUUM CUP OR PRESSURE BOX TO DETECT LEAKS		

Table 8-1. Materials and Equipment - Continued

COVERALLS, WHITE	MIL-C-2202, TYPE II	8405-00-037-9184 8405-00-037-9234 8405-00-037-9247 8405-00-037-9280 8405-00-037-9281	EA EA EA EA EA	APPROVED OUTER GARMENT CLOSED CUFLET AND ANKLET, NO POCKETS AND NO SPARK PRODUCING BUTTONS.	DLA DLA DLA DLA DLA	SMALL MEDIUM LARGE X-LARGE XX-LARGE
COVERALLS TRI-LAYER NYLON	MIL-DTL-31011A TYPE III	8415-01-500-9312 8415-01-500-9100 8415-01-500-9313 8415-01-500-9101 8415-01-500-9099	EA EA EA EA EA	OUTER GARMENT FOR WET FUEL OR WET CELL/TANK WORK		SMALL MEDIUM LARGE X-LARGE XX-LARGE
DESEALANT	MIL-D-9063, TYPE I	6850-00-861-9297	GL	SOFTEN SEALANTS TO FACILITATE SEALANT REMOVAL	GSA	
DETERGENT NONIONIC	MIL-D-16791, TYPE I	7900-00-282-9699	GL	GENERAL PURPOSE AIRCRAFT CLEANER AND ALSO USED FOR LEAK DETECTION FLUID	GSA	
DYE, LIQUID	MIL-D-81289	6820-00-412-2296	GL	MIXED WITH FUEL AND USED TO DETECT LEAKING FUEL TANKS	GSA	YELLOW
ETHYLENE GLYCOL				USED TO PREVENT WATER IN MANOMETER FROM FREEZING		
EPOXY TABS	EPOXY TABS TYPE O	8030-01-265-2895	BX	FUEL TANK REPAIR	FLZ	24 EA
EPOXY, FAST SETTING	04001	8030-01-265-2895	BX	REPAIR EXTERNAL LEAKS	FLZ	24 EA
ETHYL-ACETATE	TT-E-51	6810-00-245-6694	CN		S9G	5 GALLON
ELECTRIC KNIFE				USED TO CUT FOAM MATERIAL. THE KNIFE SHOULD HAVE A TUNGSTEN CARBIDE BLADE		
FABRIC, PATCH MATERIAL	FT-237	8305-00-137-2466	YD	FUEL CELL REPAIR	JDC	36″ X 36 ″

Table 8-1. Materials and Equipment - Continued

FABRIC, SHEET, NY-LON SANDWICH	PF 10034	8305-00-286-9905	YD	CELL REPAIR	JDC	
FACE SHIELD	A-A-1770	4240-00-542-2048	EA	FACE PROTECTION	GSA	
FLASHLIGHT	IN2-MS	6230-01-390-1727	EA	INSPECTION AND REPAIR		
FAN, VENTILATING	NF-14-2	4140-01-096-1596	EA	AIR PURGE AND VENTI-LATION	S9G	12 INCH 2200 CFM
FOOT WEAR/NEO-SOCK	CHOTA OUTDOOR GEAR	part No. NS100 FW6316	PR	LOCAL PURCHASE		
GAUZE PADS	MIL-C-87962, TY-2	7920-01-104-5406	BG	FUEL TANK CLEANING	GSA	4″ X 4″ 200 ea
GLOVES, CHEMICAL RESISTANT	MIL-G-87066	8415-01-147-6263 8415-01-147-9540 8415-01-012-9294 8415-01-013-7382 8415-01-013-7384	PR PR PR PR PR	HAND PROTECTION DURING SOLVENT CLEANING AND DEPUDDLING	S9T S9T S9T S9T S9T	SIZE 7 SIZE 8 SIZE 9 SIZE 10 SIZE 11
GLOVES, COTTON	A-A-1665	8415-00-268-8330	PR	HAND PROTECTION	S9T	REGULAR
GLOVES, LEATHER PALM, KNIFE CUFF	JJ-G-451	8415-00-634-4661	PR	INSERTS	GSA	REGULAR
GOGGLES	A-A-1110	4240-00-052-3776	EA	EYE PROTECTION	GSA	
HEAD COVERING						
HEATING IRON	2F1-3-2572RVH 2F1-3-2572-1	4920-01-113-1833 4920-00-137-6916	EA EA	APPLY HEAT FOR CELL AND TANK REPAIRS	FPZ FPZ	290 DEG F 240 DEG F
HOT PATCH AIRFOAM	53-52003-50	9320-01-187-8461	FT	FUEL TANK REPAIR	S9G	1/4″ X 52″ X 72 YD
INSPECTION PENETRANT (ZYGLO)	ZL22			NDI TESTING		
KAYDRY TOWELS	UU-T-1447	7920-00-965-1709	BX	GENERAL PURPOSE CLEANING	GSA	90 PER PACKAGE, 15 PACKAGES PER BX
KNEE PAD	A-A-1748	4240-00-595-3861	PR	KNEE PROTECTION DURING TANK MAINTE-NANCE	GSA	

Table 8-1. Materials and Equipment - Continued

LEAK DETECTION COMPOUND (FLUID)	372E	6850-00-935-4068	CA	FUEL TANK LEAK DETECTION.	GSA	FOUR 12 oz BOTTLES
LEAK DETECTION POWER	LD-4 ELDORADO (55208)	6850-00-909-3121	CA	FUEL TANK LEAK DETECTION	S9G	6 OUNCES
LIGHT, EXPLOSION PROOF	MIL-L-83762 MIL-W-21751	6230-00-042-5671 6230-00-283-9671	EA EA	APPROVED LIGHTING FOR HAZARDOUS AREAS	S9G S9G	26 X 3.5 19 X 1.8
MANOMETER, WATER	68E36424	4920-00-834-3992	EA	LOCAL MANUFACTURE, USED AS A PRESSURE RELIEF AND TO MEASURE VACUUM OR AIR PRESSURE ON A TANK.	FPZ	FOR AIRCRAFT
MARKER, FELT TIP	GG-M-114	7520-00-558-1501 7520-00-973-1059	SE DZ	GENERAL PURPOSE MARKING	GSA GSA	MULTICOLOR BLACK
METHYL, ETHEYL KETONE (MEK)	TT-M-261	6810-00-281-2785	GL	CLEANING FUEL TANKS	S9G	
METHYL, ISOBUTYL KETONE (MIBK)	ASTM D1153	6810-00-286-3785	GL	CLEANING FUEL TANKS	S9G	
MANOMETER, WATER	F52828-116	4920-00-793-0650	EA	SAFETY DEVICE TO PREVENT OVER PRESSURIZATION OF CELLS AND TANKS AND TO MEASURE AIR PRESSURE	FPZ	FUEL CELL
MIXING MACHINE	285	4940-00-996-1566	EA	MIX SEALANTS AND ADHESIVES.	FPZ	
NAPTHA	TT-N-95	0023-88-119	GL	CLEANING FUEL TANKS	GSA	
NOZZLE, CAULKING GUN	8630-9 8646 8690 600-E	5120-00-966-5376 5120-00-966-5374 5120-00-966-8243 5120-00-670-1187	EA EA EA EA	USED TO APPLY FUEL TANK SEALANTS	GSA GSA GSA GSA	1.8″ SLOT 3/4 ″ SLOT 0.094 DIA EXTENSION
NOZZLE, CAULKING GUN	252 254 410 410-45	5120-00-167-0151 5120-00-673-1885 5120-00-801-0949 5120-00-055-4063	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/16″ X 2″ 1/8″ X 2″ 1/32″ X 4 ″ 1/32″ X 4″

Table 8-1. Materials and Equipment - Continued

NOZZLE, CAULKING GUN	420 420-45 430 430-45	5120-00-042-6577 5120-00-670-1185 5120-00-967-8151 5120-00-055-4062 -	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/16″ X 4″ 1/16″ X 4″ 3/32″ X 4″ 3/32″ X 4″
NOZZLE, CAULKING GUN	440 440-45-3 620 640-45	5120-00-773-3791 5120-00-670-1186 5120-00-167-0152 5120-00-966-5373	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/8″ X 4″ 1/8″ X 4″ 1/16″ X 6″ 1/16″ X 6″
NOZZLE, CAULKING GUN	640 640-30-2-7-8 820 820-45	5120-00-822-7194 5120-00-167-0153 5120-00-966-8270 5120-00-966-5371 -	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/8″ X 4″ 1/16″ X 8″ 1/16″ X 8″ 1/16″ X 8″
NOZZLE, CAULKING GUN	980 1004	5120-00-055-4055 5120-00-055-4054	EA EA	APPLY FUEL TANK SEALANT	GSA GSA	1/16″ X 10″ 1/8″X 10″
NOZZLE, CAULKING GUN FIL- LETING, DUCKBILL	8613 8615 974 8648	5120-00-966-5379 5120-00-966-5378 5120-00-775-1670 5120-00-966-5375 -	EA EA EA EA	APPLYING SEALANT	GSA GSA GSA GSA	5 X 3/8 4 X 1/2 4 3/8 X 3/4 5 1/8 X 3/4
NOZZLE, CAULKING GUN, FIL- LETING, WIDE	8630 8630-9	5120-00-966-5317 5120-00-966-5376	EA EA	USED WITH SEALANT GUN	GSA GSA	4 7/8 X1 7/8 4 1/4 X 1 3/4
NOZZLE, INJECTION	C-13117-1 C-14117-2 C-13117-3	5120-00-961-4996 5120-00-954-4995 5120-00-961-4997	EA EA EA EA	APPLY FUEL TANK SEALANTS	FLZ FLZ FLZ	3/32 INCH 1/8 INCH 3/16 INCH
NOZZLE, CAULKING GUN, FIL- LETING, BENT	226856 1010-45	5120-00-055-4056	EA	SEALANT APPLICA- TION.	GSA	10 x 1/32
NOZZLE, CAULKING GUN, FIL- LETING, FLARED	220568 8608	5120-00-966-5381	EA	SEALANT APPLICA- TION.	GSA	4 X 3/8
NOZZLE, CAULKING GUN, FIL- LETING, FLAT	220569 8607	5120-00-966-8244	EA	SEALANT APPLICA- TION.	GSA	6 X 1/4

Table 8-1. Materials and Equipment - Continued

NOZZLE, CAULKING GUN, FIL-LETING, STRAIGHT	220565 987	5120-00-055-4058	EA	SEALANT APPLICA-TION.	GSA	10 X 1/32
OIL, LUBRICATING	VV-L-825	9150-00-265-7301	QT	FUEL CELL PRESERVA-TION	S9G	
OIL, LUBRICATING	MIL-L-6082 GR 1065			FUEL SYSTEM PRESER-VATION, REFER TO STOCKLIST		
ONTARIO KNIFE	GGG-C-746	7340-00-680-0863	EA	THE KNIFE IS USED TO CUT EXPLOSION SUS-PRESSENT FOAM.	GSA	12 INCH
PAINT	A-A-665	8010-00-584-3150	PT	STENCIL FUEL CELLS	GSA	SPRAY
PAINT, BUNA VINYLITE LACQUER		8030-00-166-8813	CN	SELF SEALING CELL REPAIR TOPCOAT	GSA	5 GALLONS
PAPER, KRAFT	A-A-203	8135-00-160-7757	RO	PACKAGING FUEL CELL	GSA	1228’ X 2’
PENCIL, AIRCRAFT MARKING	MIL-P-83953,TY1,CL B COLOR BRITE-SILVER2101	7510-00-537-6935 7510-00-537-6930 7510-00-111-6425	DZ DZ DZ	MARKING FUEL LEAKS	GSA GSA GSA	RED YELLOW SILVER
PETROLATUM	VV-P-236, TY V, CL 2	9150-00-250-0926	CN	GENERAL PURPOSE	GSA	1.75 LBS
PHENOLPTHALIEN	O-C-215	68-00-223-7612	BT	FUEL CELL LEAK DE-TECTION	S9G	100 GRAMS
PLENUM CHAMBER	57D6188		EA	LOCAL MANUFACTURE USED TO ADAPT NON-EXPLOSION PROOF HEATERS TO SUPPLY HEATED VENTILATION AND AIR PURGE	FPZ	
PROBE, ULTRASONIC	2000	6635-01-156-3927	EA		FPZ	
PUMP, AMBIENT AIR, BREATHING	NF-15-3		EA	AIR SUPPLY FOR RESPI-RATORS.	S9C	
PUMP, BREATHING AIR, ELECTRIC, EX-PLOSION PROOF	NF23-1		EA	AIR SUPPLY FOR RESPI-RATORS	S9C	

Table 8-1. Materials and Equipment - Continued

RELEASE FILM (MY-LAR)	L-P-519	9330-00-579-6217	SH	FUEL TANK REPAIR	S9G	24″ X 30″
RESPIRATOR				REFER TO AFOSH 48-137, LOCAL BIOENVI-RONMENTAL ENGI-NEER FOR RESPIRATOR SELECTION		
RETAINER, FILLETING GUN	606 220256 612	5120-00-693-8070 5120-00-693-8069 5120-00-693-8071	EA EA EA	USED WITH SEALANT GUN	FLZ GSA GSA	
SAFETY SIGN	7331119-01		EA	"DANGER OPEN FUEL TANKS" USED TO MARK EXTERIOR OF FUEL SYSTEM REPAIR AREAS AND FACILITIES	FLZ	
SAFETY STREAMER, YELLOW	9144675-01 9144675-03 9144675-05	8345-01-355-2379 8345-01-355-2378 8345-01-355-2380	EA EA EA	"REMOVE BEFORE FU-ELING/DEFUELING"	JDC JDC JDC	12 INCH 24 INCH 36 INCH
SAFETY STREAMERS, RED	MS51700-48			"REMOVE BEFORE FLIGHT" REFER TO STOCKLIST		
SEALANT CARTRIDGE	250-CP6 250-C6 250-CP- 2 1/2	5120-00-670-3294 5120-00-670-1886 5120-00-670-3295	EA EA EA	USED WITH SEALANT GUN.	GSA GSA GSA	6 OUNCE 2.5 OUNCE
SEALANT GUN	509	5130-00-050-9886	EA	APPLY NON-CURING SEALANTS.	GSA	
SEALANT GUN	250 750 223 225 507A	5130-00-341-1931 5130-00-677-5722 5130-00-345-1179 4920-00-345-1178 5120-00-677-7439	EA EA EA EA EA	APPLY CURING SEAL-ANTS	GSA GSA GSA GSA GSA	
SEALANT MIXING MA-CHINE	285	4940-00-996-1566	EA	MIX CURING TYPE SEALANTS	FPZ	
SEALING COMPOUND (LOCTITE)	MIL-S-22437 GR A	8030-00-844-3821	BT	FASTENER SEALING	GSA	50cc (RED)
SEALING COMPOUND, ALKYDESIN (OYLTITE STIK)	OLYTITESTIK	8030-935-5841	EA	FUEL TANK REPAIR	GSA	1 OUNCE

Table 8-1. Materials and Equipment - Continued

SEALING COMPOUND, CLASS B-2	PR1826	8030-01-290-5138 8030-01-290-5139	KT KT	FUEL TANK REPAIR	GSA GSA	2.5 OUNCE 6 OUNCE
SEALING COMPOUND, B 1/2	PR1826 B 1/2	8030-01-290-5136 8030-01-290-5137 8030-01-330-6571	KT KT KT	FUEL TANK REPAIR	GSA GSA	2 OUNCE 3.5 OUNCE 6 OUNCE
SEALING COMPOUND, B 1/4	PR1826 B 1/4	8030-01-290-5135 8030-01-290-5134	KT KT	FUEL TANK REPAIR	GSA GSA	3.5 OUNCE 2.0 OUNCE
SEALING COMPOUND, CORROSION INHIB-ITED	PR1426 TY11/2 TYPE I-2 TYPE II-1/2 TYPE II-2 TYPE III-12 TYPE IV-12	8030-00-008-7207 8030-00-008-7196 8030-00-008-7198 8030-00-009-5023 8030-00-008-7203 8030-00-008-7205	KT KT KT KT KT3 KT	FUEL TANK REPAIR	GSA GSA GSA GSA GSA GSA	1 PINT 1 PINT 1 PINT 1 PINT 1 PINT 1 QUART
SEALING COMPOUND HIGH TEMPERATURE, POLYSULFIDE	MIL-S-83430 TYPE A-1/2 TYPE A2 TYPE B-1/2 TYPE B2	 8030-00-602-0107 8030-00-602-0049 8030-00-348-7888 8030-00-485-3237	KT KT KT KT	FUEL TANK REPAIR	GSA GSA GSA GSA	1/2 PINT 1/2 PINT 1 PINT 1 PINT
SEALING COMPOUND, HIGH TEMPERATURE, POLYSULFIDE	MIL-S-83430 TYPE B-1/2 TYPE B2	 8030-00-602-0039 8030-00-560-8758	KT KT	FUEL TANK REPAIR	GSA GSA	1/2 PINT 1/2 PINT
SEALING COMPOUND, LOW TEMPERATURE CURE, CLASS A-1	MIL-S-83318	8030-00-474-1419	KT	FUEL TANK REPAIR	GSA	6 OUNCE
SEALING COMPOUND, NON-CURING	MIL-S-85344	8030-01-043-2295	CA	FUEL TANK REPAIR	GSA	1/2 PINT
SEALING REMOVABLE TOOLS	No. 8 SR CUTTER No. 3 SR CUTTER 2″ BRISTLE DISC 3″ BRISTLE DISC HOLDER No. 1 No. 7 RED BUTTON No. 990 MAMDRE;	3M PART NO. 61-5001-7576-7 61-5001-7577-5 61-5001-7578-3 61-5001-7579-1 61-5000-7816-9 61-5000-7412-7 61-5000-7334-3		SEALANT REMOVAL FOR FUEL TANKS		-- 40 EA 40 EA 40 EA 5 EA 5 EA 5 EA
SEALING REMOVABLE KIT/PHEUMATIC	3M COMPANY	PART NO. 0Z7005	KT	SEALANT REMOVABLE		1 EA

Table 8-1. Materials and Equipment - Continued

SEALING REMOVABLE GUN/PHEUMATIC	3M COMPANY	PART NO. 0Z7006	EA	SEALANT REMOVABLE		1 EA
SEALING REMOVABLE KIT/MANUAL	3M COMPANY	PART NO. 0Z7007	KT	SEALANT REMOVABLE		1 EA
SKYWIPES		8030-01-466-1646 8030-01-477-7897	TB	CLEAN SEALER FROM SKIN AND TOOLS		300 EA 100 EA
SHEET, BUNA-N	W878	9230-00-202-1464	YD	FUEL CELL REPAIR	S9G	0.035″ X 30 YARDS
SHEET, CLOTH COAT-ED	MIL-C-82255,TY IV	8305-00-244-0310	YD	FUEL CELL REPAIR	S9I	0.025″
SHEET, RUBBER	MIL-R-6855	9320-00-180-3259	YD	FUEL CELL REPAIR	S9G	
SHOES	A-A-50137 (GYM) MIL-S-3794 (SAFETY)			REFER TO STOCKLIST FOR NSN.	S9T S9T	
SHOT BAG				LOCAL MANUFACTURE TO DIMENSIONS AS RE-QUIRED		
SKIN PROTECTIVE CREAM	P-S-411, TYPE 3 STARLEE INVISIBLE GLOVES	6850-00-244-4892	LB	USED AS A BARRIER UNDER GLOVES	S9G	1 POUND
SPONGE, CELLULOSE	L-S-00626, TYPE II CLASS 1, SIZE 3	7920-00-559-8462	BX	FUEL TANK DEPUD-DLING	GSA	2″X 4″X6 ″ 60 EA
STITCHER	ROLLER HORIZONTAL OFF-SET VERTICAL OFF-SET			LOCAL MANUFACTURE		
SPATULA SET	22624 TS1275-K	5120-00-056-3237	SE	SEALANT APPLICATION	GSA	SET OF 3
TAPE, ALUMINUM, PRESSURE SENSITIVE	A-A113	7510-00-684-8803	RO	LEAK REPAIR	GSA	180’ X 2″
TAPE PACKAGING	PPP-T-42	7510-00-266-6710	RO	PACKAGING AND MASKING	GSA	2″ WIDE 60 YARDS TAN
TAPE, WATERPROOF	PPP-T-60	8135-00-663-9052	RO	PACKAGING AND MASKING	GSA	1″ WIDE
THERMOMETER BIME-TALLIC	310F	6685-00-996-8899	EA	GENERAL PURPOSE	S9G	0 TO 300 F
TOLUENE	TT-T-548	6910-00-290-0048	CN	CLEANING SOLVENT	GSA	5 GALLONS

Table 8-1. Materials and Equipment - Continued

TONGUE DEPRESSOR	GG-D-226, TYPE II	6515-00-324-5505	BX		S9M	100 EA
UTILITY PAIL	B12R	7420-01-150-0716	EA	GENERAL PURPOSE.	GSA	3 GAL
VACUUM CLEANER PNEUMATIC	SS-55TC	7910-00-632-9840 7910-01-908-3235	EA EA	DEPUDDLING TANKS AND DEBRIS REMOVAL	GSA GSA	25 CFM
VACUUM CUP				THIS CUP IS USED TO CONFIRM REPAIRS, THE CUP IS USED IN CONJUCTION WITH THE LEAKAGE TRACING DEVICE.		
VACUUM/PRESSURE CUP				ALSO CALLED A DOUBLE CUP. THIS CUP HAS A VACUUM SEGMENT TO HOLD THE CUP IN PLACE AND A PRESSURE SEGMENT TO INJECT DYE INTO THE LEAK PATH		
WATER DISTILLED	O-B-41	6810-00-297-9540	DR		S9G	5 GALLONS

CHAPTER 9
DEPOT MAINTENANCE

9.1 PURPOSE.

This chapter contains the safety, health, and environmental requirements necessary to conduct fuel systems maintenance at depot level only with special emphasis on the requirements for tank and cell maintenance. This chapter covers personnel, facilities, equipment, and aircraft. Only Depot Level Maintenance operations are found in this chapter. All maintenance that is preformed at Depot Level and is also preformed at Field Level (unless other wise specified) will be found in the appropriate chapters of this T.O.

9.1.1 General. The provisions of this chapter are minimum requirements for average conditions. These provisions apply to fuel systems repair personnel and non-fuel systems repair personnel (for example: electricians, safety, and supervisory personnel) at depot level. This chapter also covers confined space training requirements and emergency response team requirements for depot level.

9.1.2 Aircraft at Air Logistics Centers and AMARC. The provisions of paragraph 9.5.1 through paragraph 9.5.2 of this chapter will apply to Depot Maintenance from the time the aircraft has been properly fluid purged, depuddled, and made safe. ALCs and AMARC will establish and document procedures to include a permit system for all other tank entries consistent with the safety and health requirements of AFOSH 91-25 and CFR 1910.146.

9.2 DEPOT MAINTENANCE.

9.2.1 Hangared aircraft at an ALC, as a minimum, will meet the fire safe definitions contained in Chapter 5. Ramp areas used for fuel system repair may be designated in accordance with NFPA 410. When ramp areas are designated in accordance with NFPA 410 the ALC Safety office, Fire Department, and Production Division Chief will develop and implement controls necessary to ensure foot and vehicular traffic are directed around fuel system maintenance areas.

WARNING

- When aircraft fuel tanks/cells are blow purged alone, potentially flammable environments can be rapidly regenerated once the air source is removed. Blow purging to 5% of LEL or 300 PPM will not be considered as compliance with paragraph a through d.

- The provisions of paragraphs a through e shall apply only if the combustible gas indicator is capable of accurately measuring the %LEL in the 0 to 5% range or 0 – 300 PPM range. A PID or equivalent meter shall be used to determine if the atmosphere in the tank is less than or equal to 5% LEL or 300 PPM.

9.2.2 Once an aircraft has been fluid purged as prescribed in paragraph 9.5, drained to the fullest extent practical (including fuel lines), depuddled and mopped out, and if a LEL of 5%, or 300 PPM or less is maintained in accessible, open fuel cells/tanks (verified as required by paragraph 9.8) then:

a. Non-fuel and fuel cell repair maintenance can occur simultaneously.

b. If all hazards are eliminated (and documented) i.e., (no mechanical, electrical, chemical, or atmospheric hazard), no permit will be required to enter fuel tanks. The use of respiratory protection may still be required to prevent exposure to specific substances in accordance with other health standards. An atmosphere which could have health effects from exposure but will not cause incapacitation or limit the ability for self-rescue is not considered a hazardous atmosphere for a confined space.

c. Fuel cell/tank repair can be performed by two people. One individual will enter tank/cell. The second will serve as an attendant to monitor activity around the entered tank and to maintain contact with the individual in the tank/cell.

   An attendant may monitor more than one tank/cell provided he or she can effectively maintain communication with all personnel in the tanks/cells and can easily summon help in the case of an emergency.

d. The use of non-intrinsically safe equipment is permissible.

e. Aircraft power may be applied.

f. Protective equipment and respiratory protection will be used as prescribed by each ALC BEF and Safety Office.

9.3 WEATHER.

9.3.1 Depot Maintenance at Air Logistics Centers (ALCs). When high winds are considered dangerous (usually 30 kts/hr or higher) or thunderstorms/lightning are within a five nautical mile radius of the repair site operations shall be suspended on aircraft not fully enclosed within a hangar and meeting the requirements of paragraph 2.11. Work may continue on fully enclosed aircraft serviced with JP-5/8. The Production Division Chief in coordination with the Base Weather Officer will develop and set up warning procedures so timely precautionary measures may be taken when conditions warrant. When the Base Weather Officer provides notification of severe weather (usually at five (5) miles), Production Division supervisory personnel shall take action as necessary to ensure operations are suspended by the time the severe weather is within five (5) nautical miles. When operations are suspended, access panels, filler caps and other openings removed for maintenance shall be temporarily closed on all aircraft which do not meet the requirements of paragraph 2.11. Local management will determine to what extent it is necessary to close access covers, filler caps and other openings for aircraft which meet the requirements of paragraph 2.11. If temporary panels are used, panels will be manufactured from non-conductive material.

9.4 CONFINED SPACE ENTRY (FUEL CELL/TANK ENTRY).

9.4.1 General.

9.4.1.1 Confined space entry can be for various reasons (e.g., inspection, repair, rescue). Entry into IDLH atmospheres will be conducted in accordance with AFOSH 91-25. Certain sequences of events may require entry into a confined space with hazards present beyond the scope covered in this manual, these entries will be coordinated with the local Safety, Fire Dept, BEF and MXG/CC, LG/CC or civilian equivalent. Instructions contained within this chapter and other chapters of this T.O. will develop the requirements for “Permit Required Confined Spaces” in accordance with Air Force and OSHA health and safety directives. These procedures are for routine recurring entry in a non-IDLH atmosphere. Entry for rescue shall be conducted in accordance with the procedures set forth in the local rescue plan.

9.4.1.2 The requirements for the aircraft integral tanks and fuel cell confined space permit system are derived from Air Force and OSHA safety and health requirements.

9.4.2 Responsibilities.

9.4.2.1 The MXG/CC, LG/CC or equivalent is responsible for the safe execution of all entries into and work performed in aircraft fuel tanks and cells, and for issuing over his/her signature on the letter designating the Entry Authority and authorizing the issue of Entry Permits (Master Entry Permit).

9.4.2.2 Attendants have overall responsibility for monitoring the entry area inside and outside the aircraft fuel cell/tank, including termination of the entry if unsafe conditions develop.

9.4.2.3 Entrants are responsible for complying with the conditions of the Entry permit, this T.O. and the directions of the attendant at all times, including vacating the tank/cell when so directed.

9.4.2.4 MXG/CC, LC/CC, BEF, Safety, and Fire Prevention officials are responsible for evaluating and coordinating on the Master Entry Plan, in addition to those duties outlined by other Air Force directives.

9.4.2.5 Training will be provided by qualified individuals on the installation using lesson plans or training outlines approved by the Entry Authority, the responsible Safety office, BEF, and the Fire Department.

9.4.2.6 Vigilance is required on the part of all personnel who work in fuel cells/tanks (confined spaces).

9.4.2.7 Personnel Requirements. When entering a cell/tank a minimum of two people will be used. One 2A6X4 person (or civilian equivalent) shall enter the tank; one 2A6X4 person (or civilian equivalent) shall remain outside the tank as an attendant.

a. The Entry Authority shall designate a fuel tank entry chief for each tank entry. The fuel tank entry chief will have supervisory control over all other team members. Qualified attendants may serve as the tank entry chief.

b. The MXG/CC, LG/CC, or civilian counterpart may substitute a non-2A6X4 person as an attendant when circumstances require, such as work stoppage due to fuel system personnel manning shortages or surges in workload to sustain readiness. The acceptance of reasonable risk should be weighed by the person exercising this authority to assure that safety is not compromised. Any non-2A6X4 individual selected, as an attendant shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief or designated alternate. The local training shall cover tank familiarization, safety equipment, grounding, bonding, purging procedures, depuddling, operations, using respirators, recognizing symptoms of toxicity from fuel and solvent vapors, and rescue/emergency procedures as well as the general duties of an attendant.

c. Training or resertification shall be conducted annually.

d. When authorized by the Entry Authority or Designated alternate an attendant may monitor more than one tank entry, as long as he can effectively perform the duties of an attendant.

e. When authorized by the Entry Authority or Designated alternate, the third person may perform the runner/equipment monitor duties for more than one cell/tank entry as long as the runner/equipment monitor remains in the immediate area of the cell/tanks, e.g., within shouting distance, and is otherwise capable of executing any responsibilities assigned as the runner/equipment monitor by the Emergency Response Plan.

9.4.3 Emergency Response Plan and Procedures.

9.4.3.1 Each repair activity in coordination with installation medical services, Fire Department, Safety, and BEF officials, will develop a written Emergency Response Plan. The plan will establish a rescue team consisting of personnel to remove individuals incapable of self-rescue from tanks from which such a removal is possible, and base or local emergency response agencies to provide immediate medical care, and removal if not otherwise possible. The plan will account for all foreseeable rescue situations. Minimum requirements are listed below:

WARNING

All attendants will have the capability of summoning the emergency response team on site.

9.4.3.2 For those tanks/cells that entry for removal is possible, the plan will identify either the authorized attendant or the runner/equipment monitor for initial removal attempts employing the following procedures.

a. Prior to any tank entry for removal of an incapacitated entrant, the attendant will alert the emergency response team.

b. Ensure that the tank is being properly ventilated.

c. Determine, through contact with the entrant if possible, the nature of the emergency.

d. Assess the conditions of the tank.

e. Make any rescue attempts possible from outside the tank.

9.4.3.3 Emergency Response Plans will list equipment and facility requirements necessary to safely remove an incapacitated entrant.

9.4.3.4 Emergency Response Plans will define the roles and activities of all responding emergency agencies, including rescue from a tank from which removal by the attendant has failed or is not possible.

9.4.3.5 Rescue capabilities must exist for all shifts during which tank entry is accomplished.

9.4.3.6 Although the most likely rescue will be from a non-IDLH environment, the plan will account for rescue from an IDLH environment.

9.4.3.7 The plan will be exercised at least once every year, during which the rescue team will practice making removals from actual or simulated tanks. Dummies or mannequins can be used for the exercise.

9.4.3.8 At Depot Level immediate removal will be performed by Fire Department Personnel except when removal can be accomplished by the attendant from outside the confined space.

9.4.4 Confined Space Entry Requirements.

9.4.4.1 General.

a. All aircraft integral tanks and fuel cells will be considered permit required confined spaces. A permit shall be obtained prior to making a tank entry.

b. Exception - if the maintenance or inspection procedures require only hand/arm entry into a confined space and there is no possibility of injury from electrical or mechanical hazards, no permit is required.

(1) Tanks containing atmospheres considered to be immediately dangerous to life and health (IDLH) will not be entered using the confined space entry procedures of this chapter. For the purposes of this T.O., IDLH is considered to be LEL of greater than 20% or (1200 ppm), oxygen content of 16% or less or greater than 23.5%, or a toxicity level of any chemical agents used in the tank at or above IDLH levels specified by BEF.

(2) Tank entries for the purposes of rescue will be performed by trained, predestinated teams as specified.

(3) All participants in tank entries at depot level will be trained as outlined in this chapter of the T.O. Unattended entry shall never be authorized.

9.4.4.2 Master Entry Permit. The Master Entry Permit certifies the Fuel Systems Repair Supervisor to act as the

Entry Authority for aircraft fuel cell/tank entries. The Master Entry Permit does not authorize entrance into any permit-required space. The Master Entry Permit will be developed by the organization performing fuel tank/cell entries and approved by MXG/CC, LG/CC, Installation BEF, Safety, and Fire Prevention Officials. The AF Form 1024, Confined Space Entry Permit, which is approved for local reproduction (LRA), with addendums and modified as necessary to meet the requirements of this T.O. or a locally developed letter may be used. Table 2-3 is a sample Master Entry Permit.

a. The Master Entry Permit will be issued for a maximum of one year.

b. The Master Entry Permit will certify, by name and position, the Entry Authority and Designated Alternates.

c. The Master Entry Permit will describe the conditions under which the Entry Authority or Designated Alternates may issue Entry Permits including:

(1) Type aircraft to which the Master Entry Permit and Entry Permits will apply.

(2) General descriptions of the routine and recurring type work to be performed during permitted entries and the work centers which will be performing the work.

(3) Authorized atmospheric conditions of the tank (e.g., tank properly purged, LEL, Oxygen, toxicity at prescribed levels).

(4) Type chemicals, sealants, adhesives, etc. authorized to be used in the tank. Generally, any required by T.O. 1-1-3 procedures should be authorized, along with any other routinely used material that has been fully evaluated and approved by the local safety, fire, and BEF.

(5) Procedures, practices and personnel requirements for periods of deployment to non-Air Force installations or during readiness exercises and operations at remote locations.

(6) Additional location specific conditions deemed necessary by local BEF, Safety, or Fire Officials.

d. The Master Entry Permit will specifically state that any entry not consistent with the conditions of the Master Entry Permit will not be authorized by the Entry Authority or any Designated Alternates.

e. As part of the annual authorization process, the MXG/CC, LG/CC, BEF Ground Safety, and Fire Prevention officials must review, validate and approve the Master Entry Permit. This approval will be based on reviews and assessments of:

(1) Maintenance fuel cell/tank familiarization training and related confined space training programs developed as required by MXG/CC, LG/CC, BEF, Ground Safety and Fire Prevention Officials.

(2) The selection process for Designated Alternate Entry Authorities.

(3) Entry Permit issuing procedures.

(4) The operation and condition of sampling equipment (i.e., combustible gas indicators and oxygen meters, and other direct reading instruments).

(5) The condition and use of personal protective equipment.

(6) The organizations Fuel Cell/Tank Emergency Response Plan.

9.4.4.3 Designated Alternate Entry Authorities. Designated Alternates are selected by the Entry Authority and Certified on the Master Entry Permit. There should be sufficient Designated Alternates to ensure coverage of all operations and shifts. Designated Alternates will as a minimum be:

a. Fully qualified on aircraft fuel system maintenance.

b. Knowledgeable of the hazards of a confined space, the testing and monitoring requirements of the specific confined spaces, the rescue procedures, and the confined space entry requirements contained in this T.O.

9.4.4.4 Entry Permit Issue. The Entry Authority/Designated Alternate will:

a. Only issue an entry permit after all controls and testing are accomplished.

b. Never permit entry into a tank or cell with an IDLH atmosphere.

c. Ensure all entries and work performed adhere to the safety practices and procedures contained in this T.O.

d. Establish and maintain a system for controlling entry into all aircraft fuel tanks and cells.

(1) The Entry Authority or Designated Alternate will only issue a Entry Permit for tank entries performed under conditions consistent with the Master Entry Permit. Entry Permits may be issued for similar tasks performed under similar conditions in different tanks/cell on the same aircraft. The Entry Permit will cover the duration of the task(s) to be performed unless conditions under which the Entry Permit was issued

change prior to task completion. The Entry Permit will never be issued for more than one year.

(2) The Entry Authority or Designated Alternates will amend or reissue the Entry Permit if conditions of the original Entry Permit change prior to task completion and if the changed conditions are consistent with the Master Entry Permit. Entry Permit conditions are considered changed if:

(a) The originally permitted task(s) change.

(b) The aircraft is moved.

(c) Conditions not in adherence to this T.O. develop

(d) Chemicals other than originally permitted are introduced into the tank.

(e) Previously non-permitted personnel require entry into the tank.

(f) Any condition outside the scope of the Master Entry Permit develop. Any conditions or changes not consistent with the Master Entry Permit require approval from MXG/CC, LG/CC, BEF, Ground Safety, and the Fire Department before entry.

(3) The Entry Permit will be a written document. The AF Form 1024, Confined Spaces Entry Permit, which is authorized for local reproduction (LRA), with addendums and modified as necessary to contain the requirements of this T.O. as well as additional guidance that may be dictated by local conditions or a locally developed form may be used. Table 2-2 is a sample Entry Permit.

(4) The Entry Permit will be available at the job site during tank entry. When the task is completed, the Entry Permit will be returned to the Entry Authority and canceled. The canceled permit shall be forwarded to the local Ground Safety Office and retained for one year.

e. Ensure all entrants are qualified for tank entry.

(1) Entrants, as a minimum, must be medically qualified, respirator certified in accordance with AFOSH 48-137, have received hazard communication training in accordance with AFOSH Standard 161-21, and had fuel tank/cell familiarization training as required by this chapter of this T.O. including: Confined space hazards related to fuel cells, personnel protective equipment requirements, and self rescue.

(2) Prospective entrants not meeting the above qualifications will not be permitted entry into a tank or fuel cell.

f. Ensure attendants are trained and available for all entries.

(1) The Entry Authority or Designated Alternate shall provide a fully qualified Fuel Systems Repair specialist to act as an attendant for all entries. Attendants will be knowledgeable of the following: the emergency response plan and procedures, proper use of communication equipment, procedures for summoning rescue team and positioning of emergency equipment, recognition of early behavioral signs of potential overexposure caused by chemicals used in the tank, and the duties of an attendant. Under certain exceptional circumstances, other than fuel cell repair specialists may be selected as attendants.

WARNING

Improperly executed fuel tank/cell rescue attempts will result in severe injuries or deaths. Attendants must never enter a permitted confined space, including for rescue, unless allowed by the Emergency Response Plan. In the event of an emergency, the attendant must summon help, and make all attempts possible to rescue the entrant without entering the tank or cell.

(2) The attendant will be stationed at the entrance and remain outside of the entered tank. Duties of the attendant include: monitoring of activities inside and outside of the tank for the detection of hazards; monitoring of individuals in the tank for signs of overexposure; limiting entry into the tank to Entry Permit authorized personnel only and preventing unauthorized personnel from entering the tank; evacuating all entered tanks in the event of an emergency or other hazardous situations within or outside of the tank(s) which would endanger the entrant(s); evacuating the tank for any condition which would cause the attendant to focus attention away from the tank; and implementing the Emergency Responses plan if needed.

(3) Attendants may monitor more than one tank entry if capable of performing the duties listed in this chapter of the T.O.

(4) The use of electronic or video personnel monitors are encouraged and may reduce the number of attendants required to monitor tank entries.

(5) These devices when used properly, provide nearly continuous monitoring of personnel inside large airframe tanks. If used, sufficient attendants to control the area around the space and prevent unauthorized entry will still be required. Such devices must meet NFPA 70 requirements for use in Class I environments.

9.5 FLUID PURGE PROCEDURES.

9.5.1 MIL-F-38299 Purging Fluid Procedures.

9.5.1.1 Equipment and Materials Required. Equipment to fuel and defuel aircraft, purge fluid, safety containers, bowsers, combustible vapor meter.

9.5.1.2 Procedure.

a. Defuel aircraft in accordance with applicable manual.

b. Opens sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank that contained JP-8 may not remain under 20 percent (1200 PPM) if the ambient temperature exceeds 75°F at standard atmospheric pressures. If it is expected the temperature will exceed 75°F the tank should be purged with another fluid or air purged.

c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent (or 1200 PPM) the aircraft is fire safe. If LEL is less than 10 percent (or 600 PPM) (20 percent or 1200 PPM for foam removal) the aircraft is entry safe.

d. Test purging fluid for solids contamination and flashpoint. Flash point shall be 121°F or higher when tested in accordance with ASTM D93. Solids contamination shall meet the requirements of T.O. 42B-1-1 for JP-4 aircraft fuel. Periodically during the purge procedure the flashpoint of the fluid shall be tested. Purging shall cease any time the flash point of the fluid drops below 120°F. Use aeration or other acceptable procedures to restore the fluid to within 10 to 15 degrees of the original flashpoint.

e. If aircraft contains explosion suppression foam test conductivity of purging fluid prior to purging. Conductivity of purging fluid shall be between 100 and 700 conductivity units (CU) prior to starting purge operation. Conductivity will degrade with each use. Monitor and ensure conductivity of fluid remains between 100 to 700 CU. Blend conductivity additive into fluid as necessary.

(1) Conductivity test procedure. Obtain a one-pint sample of fluid to be tested. Test conductivity in accordance with T.O. 42B-1-1 using portable conductivity meter. Since conductivity is temperature dependent conductivity should be tested within five minutes of obtaining sample. Record fluid temperature with each conductivity measurement.

(2) Blending procedure for conductivity additive. Antistatic additive is available in one-gallon cans. If conductivity is below 100 cu, blend three parts by volume of additive to one million parts by volume purging fluid. The additive should be diluted by adding nine parts purge fluid to one part additive. Inject the mixture below the surface level of the fluid in the tank by using a funnel or rubber hose. Extend the hose through a hatch in the top so the end is below the surface of the purge fluid. This will eliminate the possibility of a static discharge, which could be created from the free fall of the additive if it was poured through the vapor space. The additive disperses slowly in the purging fluid. Dispersion can be accelerated by adding the additive to a tank prior to receipt of new product, circulating the fluid or by aeration. If such mixing is impractical the mixture should be allowed to sit for twelve hours to allow the additive to disperse.

f. Fluid may be stored in a fuel trailer or storage tank. Mark container to denote contents.

g. Connect purging fluid supply to aircraft.

h. Fill each tank. Each tank may be filled separately and transferred to any other tank or throughout the complete system. The fluid shall remain in the tank for a minimum of 10 minutes before removal or transfer.

i. Evacuate fluid from tank.

j. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.

k. Check lower explosive limit. If LEL is not below 20 percent or 1200 PPM repeat purge procedure. If the tank is to be entered repeat the purge procedure until entry safe LEL and oxygen level is attained.

l. Depuddle tanks as necessary. Maintain mechanical ventilation and comply with all requirements of the entry permit during entry.

m. For hangared aircraft the LEL shall be checked daily or more often as deemed necessary. Normally a LEL check will be made at the beginning of each shift.

9.5.2 JP-5 and JP-8 Fluid Purging Procedures.

9.5.2.1 Equipment and Materials Required. Equipment to fuel and defuel, purge fluid, oil, safety containers, bowsers, oxygen analyzer, combustible vapor meter.

9.5.2.2 Procedures.

a. Defuel aircraft in accordance with applicable manual.

b. Opens sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank that contained JP-8 may not remain under 20 percent if the ambient temperature exceeds 75°F at standard atmospheric pressures. If it is expected the temperature will exceed 75°F the tank should be purged with another fluid or air purged.

c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is fire safe. If LEL is less than 10 percent (20 percent for foam removal) the aircraft is entry safe. Additional purging is not necessary.

d. Test purging fluid for solids contamination and flashpoint. Flashpoint shall be 121°F or higher when tested in accordance with ASTM D93. Solids contamination shall meet the requirements of T.O. 42B-1-1 for JP-4 aircraft fuel. Periodically during the purge procedure the flashpoint of the fluid shall be tested. Purging shall cease any time the flash point of the fluid drops below 120°F. Use aeration or other acceptable procedures to restore the fluid to within 10 to 15 degrees of the original flashpoint. JP-5 and JP-8 may be blended with not less than four parts JP-4 to make a mixture that can then be used to service aircraft or engines that operate on JP-4. The fuel quality of the blend shall meet the requirements of T.O. 42B-1-1.

e. JP-5 and JP-8 contain conductivity additives. The addition of conductivity additive should not be necessary.

f. Fluid may be stored in a fuel trailer or storage tank. Mark container to denote contents.

g. Connect purging fluid supply to aircraft.

h. Fill each tank. Each tank may be filled separately or transferred to another tank. The fluid shall remain in the tank for a minimum of 10 minutes before removal or transfer.

i. Evacuate fluid from tank.

j. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.

k. If LEL is not below 20 percent or 1200 PPM repeat purge procedure. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent or 1200 PPM the aircraft is fire safe. If LEL is less than 10 percent or 600 PPM (20 percent or 1200 PPM for foam removal) the aircraft is entry safe. Additional purging is not necessary.

l. Depuddle tanks as necessary. Maintain mechanical ventilation and comply with all requirements of the entry permit during entry.

m. For hangared aircraft the LEL shall be checked daily or more often as deemed necessary. Normally a LEL check will be made at the beginning of each shift.

9.5.3 Ventilation Procedures. (Fluid Purge Only).

9.5.3.1 Ventilation is used to provide fresh air to the entrant. Tanks requiring an air supply to maintain or lower the LEL or chemical concentrations shall be considered air purged. Tanks can be ventilated using the same equipment and connections as required for an air purge or any locally approved procedure.

9.5.3.2 When applying ventilation to a tank:

9.5.3.3 Check the LEL once per shift or more often as deemed necessary.

9.5.3.4 Ensure no fuel is brought into the tank. Solvents, sealants, adhesives or other chemicals are permitted in quantities which will not cause the generation of a hazardous atmosphere. If these items are brought into the tank in quantities which can generate a hazardous atmosphere, initiate air purge procedures.

9.6 INSPECTION PROCEDURES FOR DEPOT MAINTENANCE OF TIME-PHASE SCHEDULED AIRCRAFT AT AFMC DEPOTS OR CONTRACTOR FACILITIES.

9.6.1 Aircraft Using Self-Sealing Cells. If an aircraft MDS has a history of fuel cell activation all cell shall be removed and inspected. If there is no history of activation on a particular aircraft MDS, the aircraft shall be inspected for visible leakage with fuel in the system.

9.6.2 Aircraft Using Bladder-Type Cells. Aircraft shall be tested for leakage while there is fuel in the system.

9.7 REPAIR OF FITTINGS.

9.7.1 Replacing Fittings (Self-Sealing and Bladder Cells). Fitting replacement is not generally considered a difficult operation, although it is a lengthy one. Care shall be taken to achieve accuracy. The materials and tools are the same as those used for other repairs.

9.7.2 Repair of Fitting O-Ring Groove Area. Damage to fittings in some instances is cause for rejection of an entire fuel cell particularly when replacement fittings are not available. This situation, unfortunately, is most prevalent with fuel cells of limited production, used in aircraft no longer being manufactured. Since there is normally a requirement for this type of equipment, it is necessary to maintain the capability of servicing these fuel cells and replacing or repairing the fittings. It is advisable to retain a stockpile of salvaged fittings from scrap fuel cells in order to readily replace damaged fittings without undue delay. However, when new or used replacement fittings are not available or obtainable within a reasonable length of time, the ability to repair fittings is invaluable. Prevalent damages that occur to fittings are cracks and breaks of the O-ring groove and flanges. This results from improper disassembly or improper alignment when connected to adjacent assemblies. The O-ring groove flanges are generally thin in cross-section as compared to the body of the fitting and therefore break more readily. When the damaged fitting cannot be conveniently replaced or a replacement fitting is not obtainable and the break is confined to the fitting O-ring groove area, a satisfactory repair can be made. Two types of repairable damage are recognized:

9.7.2.1 Broken O-ring groove flanges. The flange between the O-ring groove and the fitting opening is sometimes broken or chipped due to incorrect installation of a cover plate or fitting.

9.7.2.2 Break of the fitting body extending from the corner at the outside diameter of the O-ring groove through to the fuel cavity.

9.7.2.3 Light burrs, scratches, nicks or other damage to the sealing surface of fittings with or without O-Ring grooves. Damage up to 0.005 inch will be repaired in accordance with paragraph 7.10..

9.7.3 Extent of Damage. Fittings should not be repaired if badly distorted or if the cracks are other than simple straight or slightly curved cracks. Do not repair cracks through O-ring groove areas if longer than twice the distance between adjacent threaded inserts. Do not make more than two repairs on any fitting. Both types of repair are to be at least 90 degrees apart and, in no case, closer than 9 inches measured circumferentially between the ends of the repairs. Do not repair broken O-ring flanges if the damaged area is over one inch long.

9.7.4 Repair of Broken O-Ring Groove Flange.

9.7.4.1 If the fitting is distorted, reshape using the bolt-ring portion of the mating part as a guide. Conveniently shaped dolly blocks and soft-faced hammers may be used to restore the fitting to its normal shape. Use caution to prevent further damage to the fitting.

9.7.4.2 Contour the damaged area to receive the epoxy resin-patching compound. Use suitably shaped rotary files and scrapers for contouring. These scrapers are also used in dressing the completed repair. Figure 7-28, illustrates the tang end of a file being used as a scraper. Note the ground taper. Using rotary file, clean up the jagged edges of the break. Cut a taper in the bottom of the O-ring groove (See Figure 7-28). The taper shall be such that the outer diameter of the O-ring groove remains at its original level while the inner diameter of the retainer land base will be ground to within 1/64 inch to 1/32 inch from the inner surface of the fitting. The taper is in the radial direction. The taper shall extend circumferentially from one end of the repair to the other. As the grinding tool approaches the end of the damaged area, rotate the tool to maintain the angle of taper on the bottom of the O-ring groove while meeting the inner face of the O-ring groove flange at an angle of 30 degrees to the tangent. Holding the tool in this position, grind a 30-degree knife-edge taper on the inner face of the flange. Fair the tapers into each other at this intersection. A cone shaped rotary file is best for grinding the inner face of the flange.

9.7.4.3 Use a 180-grit emery cloth and sand all ground surfaces thoroughly. Wash all dirt and grit from the repair area with solvent.

9.7.4.4 Fabricate two retainer rings from aluminum alloy sheet of convenient thickness to retain the patching compound. One ring is to fit the inner face of the flange and the other ring is to fit the outer face. Form the rings so that spring back will hold them in place. The inner ring should be approximately 1/16 inch to 1/8 inch higher than the flange. The outer ring can be adjusted to the same height by sliding it up or down. (See Figure 7-28.)

9.7.4.5 Cover the faces of the rings that will be in contact with the patching compound with cellophane of equivalent tape. Clean the damaged fitting with solvent and install the rings in place on the fitting, being sure that they contact the repair area securely.

9.7.4.6 Mix the epoxy-patching compound. Fill the space between the rings with patching compound. Use a thin instrument such as a tongue depressor to work the compound. Avoid entrapment of air pockets. As the space between the rings is filled, the compound oozes under the ring and onto the taper on the bottom of the O-ring groove. Spread the compound, as necessary, to bring the level slightly higher than the surrounding area.

9.7.4.7 Allow the repair to cure at room temperature 8 to 16 hours or until it is solid. Remove the retainer rings. Remove any excess epoxy from the O-ring groove with a scraper; also use an air nozzle to remove the epoxy particles during the scraping operation.

9.7.4.8 Dress the repair to match the contour and surface finish of the fitting. Maintain the dimensions of the O-ring groove accurately.

9.7.5 Repair of Break through the Fitting Body. Cracks occur on fittings having a wide O-ring retainer land and a relative thin cross-section through the bottom of the O-ring groove. Repair as follows:

9.7.5.1 Straighten the fitting if it is bent. Use caution to avoid further damage to the fitting. Stop drill the ends of the break with a No. 50 drill.

9.7.5.2 Working from the inside, vee the break so that the bottom of the vee is approximately one-half way through the work piece. The included angle between the faces of the vee should be approximately 60 degrees.

9.7.5.3 Use 180-grit emery cloth to sand the surrounding area thoroughly.

9.7.5.4 Use a jeweler's disc saw to score the insert bosses and land to 1/32 inch depth. Score the fitting along two lines. Use a hacksaw blade scraper ground to have a round cutting edge to remove the sharp corners at the bottom of the jeweler's saw scores. Do not score the fitting in areas which cannot be reached by the hacksaw blade.

9.7.5.5 Vee out the portion of the crack remaining in the O-ring groove. Since the breaks usually occur next to the rear vertical face of the groove, it will be necessary to slightly undercut this face in order to clean up the break. Thoroughly clean the repair area with solvent. Remove all contamination.

9.7.5.6 Provide a dam for holding the epoxy compound in place. Use noncuring aircraft sealers, modeling clay, plaster, or other convenient materials. Avoid contaminating the bonding surfaces of the repair area with these materials.

9.7.5.7 Prepare the epoxy compound and apply to the repair area. Do not trap air bubbles. Arrange the cell so that gravity will assist to hold the repair material in place as it cures. Allow the compound to cure.

9.7.5.8 Dress the repaired area in the O-ring groove to conform to the original dimensions and surface finish. Dress the edge of the reinforcement on the inside surface of the fitting using a powered cone-shaped rotary stone.

9.7.5.9 When finished with the fitting repairs, ascertain that all debris is removed from the cell cavity. Inspect the repair to determine that adhesion is complete and that the patching compound is well cured. When well cured, the compound should not dent with a fingernail. Inspect for porosity. A small number of pinpoint bubbles are acceptable.

9.7.6 Removing Damaged Fittings.

9.7.6.1 Locate the old fitting accurately by measuring from selected points of the cell so that the new fitting can be centered exactly in the same position. (See Figure 7-30.) A silver pencil shall be used when locating fittings.

9.7.6.2 A fitting shall be replaced with the same type as that removed from the cell. Relocation of fitting openings requires skill and experience and shall be attempted only by journeymen repairers.

9.7.6.3 On fittings without metal inserts cut the fitting flange flush with the outside sealing surface of the fittings. Then cut out the flange of the fitting to the edge of the cell wall. Care shall be taken to avoid cutting the cell, and enlarging the original opening.

9.7.6.4 On fittings with metal inserts, cut out the fitting, using the metal insert as a guide.

9.7.7 Installing New Fittings.

9.7.7.1 Using an emery buffer, remove enough of the inside and outside flange of the old fitting and the ply that covers it to reduce the thickness of the cell wall so it will fit between the flanges of the new fitting.

9.7.7.2 Buff the inside and outside surfaces of the cell where flanges of the new fittings are to be placed. This buffing shall cover an area extending two inches beyond the edge of the flanges when the new fitting is set in place.

9.7.7.3 If the new fitting has not been buffed, the surfaces inside and outside both flanges must be buffed.

9.7.7.4 If the cell wall does not have enough thickness to fill the space between the flanges of the new fitting, apply a patch of Buna inside repair material to the inside of the cell in the same way as when applying an inside patch. This patch shall be large enough to extend one inch beyond the area to be covered by fitting flange. Also the center shall be cut out to match the hole in the cell and all loose edges shall be trimmed. Before the patch is applied, its outside surface shall be buffed and the patch feather-edged. Before inserting the fitting through the opening, the size and shape shall be carefully checked. This can be done with a pair of calipers. The diameter of the cell opening shall not be less than the diameter of the throat of the fitting, but the diameter of the cell opening may be up to 1/4-inch larger than the overall diameter of the throat of the fitting. On fittings that are not circular, the cell opening may be up to 1/4-inch wider than the throat of the fitting to be installed.

Filler is not required for the void between the throat of the fitting and the cell wall.

9.7.7.5 Moisten the surfaces of the fitting with MEK or MIBK solvent and force the fitting through the opening in the cell, pulling the outside flange through from the inside of the cell. Check the alignment of the new fitting in the cell opening. If the opening is too small, buff until the new fitting flanges lay flat on the cell. If the opening in the cell does not allow a 1-inch bond to the new fitting flanges, the cell shall be condemned. When a satisfactory fit has been obtained remove the fitting from the cell.

9.7.7.6 Cement repair per applicable procedure.

a. Non Vithane air cure.

b. Non Vithane vulcanizing hot patch.

c. Vithane non self-sealing.

d. Vithane self-sealing.

9.7.7.7 With clean hands, insert the fitting in the opening of the cell. Align the fitting carefully so that its location is exactly the same as that of the old fitting. It may be shifted to an off-center position, if necessary, to align the bolt holes. Press the flange to the cell wall. Use the same procedure on the outside flange.

9.7.7.8 Refer to applicable procedures listed in paragraph 7.10.7. step e, for fitting activation and curing.

9.7.8 Applying Cover Patches Over Fitting Flanges on Nonvithane Fuel Cells. Apply one patch of Buna inside repair material over the inside flange after the cement applied to the fitting has dried thoroughly (45 minutes). Cut the patch 1 1/2-inches larger in all directions than the fitting flange. Cut an opening in the center the same shape as the opening in the fitting, but 1/8-inch larger in all directions. Care shall be taken to avoid getting cement on the sealing surface of the fitting. Patches are cemented and applied in the same way as are other standard patches described in this chapter. The opening shall be centered carefully so that the amount of material is approximately the same in all directions. Complete repair.

9.7.9 Apply Cover Patches over Fitting Flanges on Vithane Fuel Cells.

9.7.9.1 Apply one patch of FT235 repair fabric over the inside flange. Cut the patch 1 1/2-inches larger in all directions than the fitting flange. Cut an opening in the center the same shape as the opening in the fitting, but 1/8-inch larger in all directions. Care shall be taken to avoid getting cement on the sealing surface of the fitting. Patches are cemented and applied in the same way as other standard patches. The opening shall be centered carefully so that the amount of material is approximately the same in all directions.

9.7.9.2 Only one patch is used on the outside of the fitting. This patch shall be of outside fabric material which has been cut two inches larger in all directions than the fitting flange. The center is cut to the proper size and shape to accommodate the fitting. A patch applied to a protruding or barrel type fitting shall fit snugly around the base of the fitting barrel. A patch applied to a metal insert fitting shall have an opening 1/2-inch larger in all directions than the gasket or compression surface of the fitting.

9.7.9.3 This fitting replacement procedure may not be practical for all replacements. Inserting the fitting from the outside of the cell may sometimes be convenient. Some installations can be made more easily if the patch is cemented to the flange before the fitting is inserted. Many of these details are left to the judgment of the person making the repair, but the following steps shall always be taken.

9.7.9.4 On Vithane fuel cells, mix cement in accordance with instructions. Apply a coat of cement to the cover and the fitting flange. Allow cement to dry for 15 minutes. Apply a second coat of cement and allow to dry for five minutes.

9.7.9.5 One cover patch shall be installed on each flange of the fitting.

9.7.9.6 The outside patch on the metal insert fitting should not interfere with the gasket or compression surface.

9.7.9.7 Wrap barrel-type fittings.

9.7.9.8 On Vithane fuel cells, tape a piece of release film over the patch. Assure that the release film is larger than cemented area, and remains in place. Clamp and cure the patch in accordance with instructions.

9.7.10 Repair of Burrs, Scratches, Nicks or other Damage on the Sealing Surface (Including O-Ring Groove).

9.7.10.1 Lightly sand the damaged area with 600 grit emery cloth. Extend the sanded area no more than two inches beyond either side of the damage. A tongue depressor may be used to assist sanding.

9.7.10.2 Clean the fitting with solvent.

9.7.10.3 Apply chromate conversion coating, MIL-C-81706, in accordance with T.O. 1-1-691.

9.8 REPAIRING NONMETALLIC CELLS.

9.8.1 A nonmetallic cell is a combination fuel cell and rigid cell in a single unit. Nonmetallic cells have fabric or plastic shells made integrally with a self-sealing cell and are complete within themselves.

9.8.2 Damage to the nonmetallic portion of a cell less than 10 square inches need not be repaired if the strength of the unit is not impaired. The inner-liner of a self-sealing fuel cell should be repaired and a patch placed over the damaged portion of the nonmetallic cell to prevent fuel from attacking the damaged area. If the damaged area is more than 10 inches but less than 25 inches, the repair shall be made as outlined in paragraph 7.8.5. If some of the material is missing, the missing plies shall be replaced, using a step-down procedure with at least a 2-inch step per ply. Due to the hardness of the nonmetallic portion of the cell, do not try to cut the hose to a smooth contour. Fill the entire opening and make sure that there are no air pockets which will expand at high altitudes. The hot knife will be very useful to remove and smooth the sealant. Apply cover patches, inside and out, to extend four inches in all directions beyond the edge of the damage.

9.8.3 Fitting replacement on nonmetallic cells are made in the same way as fitting replacement on self-sealing cells. Fittings for different nonmetallic cells are interchangeable to a limited extent; fittings may be interchanged in cells which have similar construction and which are equipped with fittings with the same distance between flanges.

9.9 REPAIRING FULLY MOLDED FITTINGS (RUBBER FITTINGS WITH METAL INSERTS).

9.9.1 A fitting which requires replacement of more than 1/3 of the rubber on the sealing surface shall be replaced.

9.9.2 Materials required. Solvent (MEK, MIBK), cheesecloth, Buna-N, cement (MIL-A-9117), heater, heat, transfer fixture, buffing wheel, emery cloth, metal primer (TY-PLY “N”).

9.9.3 Procedures.

9.9.3.1 Slight weather cracks on outer sides and radius of protruding fittings where the flange and the radius merge should be repaired by applying a coat of cement (MIL-C-9117), to the crack. Do not use this procedure to repair the sealing surface.

9.9.3.2 Buff or sand damaged area. Remove enough material to ensure only sound material is exposed. If metal insert is exposed, sand insert.

9.9.3.3 Clean all surfaces with solvent.

9.9.3.4 Insert bolts which have been shortened to fit below the surface of the insert, where necessary, to prevent repair stock from flowing into the screw holes.

9.9.3.5 Apply two coats of primer to exposed metal. Apply first coat, allow 30 minutes for primer to dry, apply second coat, and allow 30 minutes drying time before proceeding.

9.9.3.6 Prepare enough strips of Buna-N material to fill the void.

9.9.3.7 Apply three coats of cement to both the fitting and Buna-N. Allow each coat to thoroughly dry before the next coat is applied.

9.9.3.8 When the third coat is dry activate the cement by wiping with cheesecloth moistened with solvent.

9.9.3.9 Place Buna-N material on fitting. Ensure enough material is used to fill the void. Excess material can be buffed off after the curing process is complete.

9.9.3.10 Locally manufacture heat transfer and pressure fixture to vulcanizing the fitting. The fixture shall consist of an internal and external pressure plate to conform to the configuration of the cell.

9.9.3.11 Install fixture on fitting and tighten. Turn heater on and regulate temperature to 290°F + 10°F. Heater should fit over the outer face of the pressure plate fixture. The heater shall be small enough to prevent heating the cell.

9.9.3.12 After five minutes retighten fixture. Continue cure for 60 minutes.

9.9.3.13 Turn heater off. Wait for fixture to cool before removing fixture.

9.9.3.14 Buff and clean the new surface, if necessary, to match original portions of cell fitting.

9.10 ALIGNMENT PIN REPLACEMENT.

9.10.1 Some molded fittings use pins to ensure the fittings properly align. Use the following procedure to replace an alignment pin.

9.10.2 Materials required. Buffing wheel, center punch, knife, drill, drift punch.

9.10.3 Procedures.

a. Buff rubber on opposite side of fitting down to insert and pin.

b. Cut rubber from around side of pin or stud.

c. Center punch the pin on the opposite side to remove pin and remove head with a drill. The remaining portion removed with a drift punch. Threaded studs shall be unscrewed.

d. Install a new pin. Using a center punch stake the pin in three equally spaced places around the pin.

e. Repair rubber (Paragraph 7.19).

9.11 O-RING FITTING REPAIR.

Many bladder and self-sealing cells have an O-ring fitting. The fitting shall be repaired in accordance with paragraph 7.10, anytime a scratch, nick or burr is found in the critical surface of the O-ring groove. Care shall be used in the inspection of O-ring fittings. Never lift, move or carry a fuel cell by the fittings; they are not handles or handholds, they are easily bent and shall be protected at all times against distortion. A piece of cardboard taped in position will protect the fitting. The sealing surface of an O-ring fitting shall be kept clean. Remove all particles of dirt, thread, tape, paint, metal shavings and other foreign material from the fitting with cheesecloth moistened with solvent and a tool made of hardwood. If, while cleaning the metal surface of a fitting, the chromate conversion coating is removed, it shall be replaced with the conversion coating MIL-C-81706 in accordance with T.O. 1-1-691.

9.12 LACING CORDS AND KNOTS.

Many cells use nylon lacing cords to hold cells in place.

9.13 TESTING OF SEALANTS.

9.13.1 ALC and Contractor Maintenance Activities. This paragraph describes procedures to be applied by ALC and contractor activities when large amounts of curing type sealants are to be tested. A large amount is considered 5 gallons or more, base material, mixed and/or applied to aircraft fuel tanks in a five-day period. Mixed sealants shall be tested to assure proper quality before being released for production application. This quality assurance test shall include the following:

9.13.2 Sampling.

a. Frequency. Representative samples from each newly opened container or as requested by the sealant mixing activity.

b. One sample from each hand mixed batch.

c. Representative samples from each machined mixed run. (one sample from: first, middle and end of run).

d. Label each sample with the following:

e. Type and class or sealant.

f. Manufacturer.

g. Date of manufacture and lot number.

h. Date mixed.

i. Run number.

9.13.3 Laboratory Testing.

a. An accelerated cure mechanism is acceptable for evaluating laboratory samples provided the cure temperature does not exceed 140°F, and the relative humidity does not exceed 50 percent. Shore A hardness evaluations for laboratory samples should be based on standard curves for hardness versus cure time developed for accelerated cure and for each individual type and class of sealant used.

b. The following tests should be conducted:

(1) Visual inspection of container and contents.

(2) Application time.

(3) Tack free time.

(4) Curing time.

(5) Shore A hardness.

(6) Peel strength (Use two aluminum panels coated with MIL-C-27725 which have been aged in jet reference fluid seven days at 140°F).

c. Refer to the applicable specification for requirements for application time, tack free time, cure time after nine months storage. The material can be extended 1/2 of the original shelf life in accordance with AFMAM 23-110 and the SLED.

d. Each sealant run, or portion thereof, must pass all laboratory test prior to being issued for production use.

e. Machine mixers that meter sealant components shall be on an inspection calibration schedule.

9.14 TRAINING.

General Information. To ensure personnel are vigilant and well informed prior to entering a permit-required confined space, it is paramount that each organization develops a structured and effective training program to establish safe work practices and techniques. The persons developing this training program will base it on specific hazards to be encountered. The trainer will obtain installation SEG, CEF, and BE officials' approval on all training lesson plans prior to their use and any time changes are made to the plans. Entry supervisors will ensure all individuals (who are authorized confined space entry to perform confined space work or are assigned as attendants or rescue personnel) are trained. Entry supervisors will ensure employees are made aware of the appropriate procedures and controls for entry and that unauthorized entry into such spaces is forbidden. (Entry supervisors will ensure employees are made aware that the consequences of unauthorized entry can be fatal. Many hazards of confined spaces are impossible to detect without the use of specially designed equipment.).

9.14.1 Entrants Entry supervisors will ensure all entrants are trained in the following subjects:

9.14.2 Hazard Recognition. Prior to entering any confined space perform appropriate testing to determine potential atmospheric hazards before entry.

9.14.3 Personal Protection Equipment (PPE). The proper use of all PPE and protective shields and barriers.

9.14.4 Self-Rescue.

a. To exit from the confined space as rapidly as they can whenever an order to evacuate is given by the attendant, whenever an automatic evacuation alarm is activated, or whenever employees recognize the warning signs of exposure to substances whose presence in the confined space is known or expected.

b. To know the toxic effects or symptoms of exposure to anticipated hazardous materials they are using.

c. To relay an alarm to their attendant and to attempt self-rescue immediately on becoming aware of the effects of exposure to substances whose presence in the confined space is know or expected.

9.14.5 Special Work Practices or Procedures. All modifications or alterations of normal work practices that are necessary for confined space work.

9.14.6 Entry Supervisor. The entry (on-site) supervisor in charge of the confined space entry and who authorizes entry into permit-required confined spaces will meet the training requirements of an entrant and be trained to accomplish the following:

a. Recognize the effects of exposure to hazards reasonably expected to be present.

b. Trained to perform the duties and responsibilities of the entrant.

9.14.7 Attendant. Entry supervisors will ensure the attendant is trained to perform the duties and responsibilities of an attendant and on the same requirements as those of an entrant.

9.14.8 Confined Space Tester and (or) Monitor. The person designated to conduct tests of confined space atmospheric conditions must be trained in the operation, calibration, and care of the specific testing equipment to be used. The person conducting the tests must be fully trained and certified as qualified to interpret the results. The tester shall meet the training requirements of an entrant if entry is required to conduct the tests.

9.14.9 Documentation of Training. All confined space training for entry supervisors, entrants, attendants, testers and (or) monitors, and rescue team members shall be certified, documented, and kept up-to-date. The certification shall contain each individual's name and dates of training or retraining and either the initials or signature of the trainer and (or) instructor. Training shall be documented on an AF Form 55, Employee Safety and Health Record, for safety related items such as CPR or respirator use, or on an authorized computerized information management system. Training records will be available for review by the CSPT during annual program evaluations or spot checks.

APPENDIX A
SHELF LIFE UPDATE METHOD
BASE LEVEL (FIELD)

A.1 SHELF LIFE UPDATING: To be used for MIL-S-8802, MIL-S-83430, MIL-S-81733, and AMS 3276 fuel tank sealants. Each batch of material should be tested separately. Randomly select one sealant kit per batch for testing.

A.2 PERFORM VISUAL INSPECTION:

A.2.1 All Packaging Except Two-Component Kits. Visually examine containers to insure the lid seal has not been broken. Discard both base and accelerator if the seal on either is broken.

A.2.1.1 Open both containers (base and accelerator) and check for skinning, if skinning has occurred in either base or accelerator, discard both.

A.2.1.2 Stir both base and accelerator. Both materials should blend well and without lumps or streaks. Discard both if either material has any evidence of lumps or streaks.

A.2.2 Two Component Kits. Check cartridge for evidence of cracks or loss of material.

A.3 PERFORMANCE TESTING:

A.3.1 Mix material in accordance with manufacturer's instructions. Material should mix well with no streaks.

A.3.2 Apply mixed material to an aluminum panel coated with MIL-C-27725, fuel tank coating. Form a bead of material approximately 1/8 to 1/4 inch high and 3 inches to 6 inches long. Material should flow well and wet the surface easily. Tool bead to make sure no air is entrapped. Discard if material does not flow easily or wet the surface easily. Record time and date.

A.3.3 After the rated tack-free time (paragraph 6.7.5 and paragraph 6.7.6) place a piece of polyethylene plastic film into the sealant. Quickly remove the plastic film from the sealant. No sealant should remain on the film. If any sealant transfers discard the sealant.

A.3.4 After the rated cure time (paragraph 6.7.7) the sealant should be firm but flexible. Push against the sealant with a tongue depressor or other blunt instrument. Sealant should adhere well to the surface. Any indication of no adhering is cause for rejection.

A.4 SHELF LIFE EXTENSION

A.4.1 If all test are passes, shelf life for material of that batch can be extended three months from the date of testing. All containers should be marked with the new shelf life date.

A.4.2 If any failure in visual inspection or testing is observed, all material from that batch should be discarded.

A.4.3 Shelf life can be extended a maximum of two times. After that, material should be discarded.

GLOSSARY

A

ABRADE	To prepare a surface for cementing or sealing by roughening.
ABRADED AREA	Scuffed area where the surface has been roughened either in preparation for cementing or sealing or accidental damage from such as chafing.
ABSOLUTE SEALING	Level of sealing for integral tanks which requires all seams, voids, slots, holes, and fasteners penetrating the tank to be sealed leak free.
ACCELERATOR	The curing agent used in multiple part curing type sealants.
ADHESION	The property of a material that makes it stick to another material.
ADHESION PROMOTER	Material applied to a surface to enhance curing type sealant adhesion.
ADHESIVE SEALING	A method of sealing faying surfaces using a structural adhesive to form a primary seal.
AFFF	Aqueous Film Forming Foam. A fire suppression agent.
AFOSH-STD	Air Force Occupational Safety and Health Standard
ATTENDANT	A trained individual outside of the confined space who acts as the observer of the entrant.

B

BASE COMPOUND	The major component of a multiple part curing type sealant, usually synthetic rubber.
BLISTER	A raised spot on the surface or a separation between the plies of a fuel cell which usually forms a void or air filled space.
BLADDER TANK	See FUEL CELL
BONDING	The equalization of static electricity charges between two or more objects.
BOUNDARY STRUCTURE	The fuel tight primary structure of an integral tank which forms the tank boundaries. Comprised of skin panels, bulkheads, and spars.
BUFFING	A method of abrasion which forms a roughened or velvety surface.

C

CAVITY	The structural members surrounding a fuel cell which act as a secondary container and help support the fuel cell.
CENTERLINE GROOVE	An injection sealing groove machined along the fastener line.
CHANNEL	A passage formed by structural discontinuity or a groove machined into a faying surface.
CHANNEL SEAL	See INJECTION SEAL
CHECKING, WEATHERING or OZONE	Short small cracks on the surface of a fuel cell, generally caused by environmental conditions.
COHESION	The property of a material that holds it together.
CONFINED SPACE	Any space with limited ingress and egress which can be bodily entered.
CORROSION PREVENTIVE COMPOUND	A material applied to a surface to provide corrosion resistance.
CPR	Cardiopulmonary Resuscitation.
CRAZING	A surface irregularity characterized by many hairline indentions or ridges.
CURE	The metamorphosis of a curing type sealant from a soft state to a firm rubbery condition.

D

DEPUDDLING	The removal of fuel or other liquid puddles from cells or tanks. Depuddling is usually accomplished with a sponge and bucket or air operated vacuum system.
DESEAL	Removal of sealant from a surface.
DESEALANT	A material used to remove or loosen some curing type sealants.
DELAMINATION	The separation of plies on a fuel cell or composite material.

DESIGNATED ALTERNATE ENTRY AUTHORITY	An individual designated by the entry authority to issue field permits. This individual shall be listed on the master permit.
DOME NUTS	Plate nuts with a mechanical seal at the base and a cap over the top to provide a fuel tight seal.
DRAINING	The removal of fuel or other liquids from cells or tanks via the aircraft fuel system drains.

E

ENTRANT	an employee who is trained and authorized to enter a confined space.
ENTRY	Any act which results in any part of an employee's body breaking the plane of the opening of a confined space or enclosed area. Includes any ensuing work in the confined space or enclosed area.
ENTRY AUTHORITY	The individual authorized by the MXG/CC or LG/CC to issue field permits. Usually the Fuel Section Chief.
ENTRY PERMIT	The permit authorizing entry into a confined space.
ENTRY PERMIT SYSTEM	A system for ensuring safe entry in a confined space, i.e., integral tank or fuel cell.
ENTRY SAFE	Conditions at which it is safe to enter a confined space. In general conditions are: 10% LEL or (600 ppm) 20% LEL or (1200 ppm) for foam removal), oxygen level between 19.5% and 23.5% and toxicity limits within the limits prescribed on the master permit.
EMERGENCY COMMUNICATIONS	Any type of communications link which is available for requesting emergency assistance.
EXPLOSIONPROOF APPARATUS	An apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor which may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes or explosion of the gas or vapor within and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.
EXTERNAL MOUNTED FUEL SYSTEM COMPONENT	A fuel system, or related, component mounted in such a manner that it is not necessary to enter a fuel cell or integral tank (other than hand entry) to remove replace or repair the component.

F

FAYING SURFACE	Surfaces which are extremely close together.
FAYING SURFACE SEAL	A seal between mating surfaces to prevent corrosion or to prevent fuel from traveling along or through mating surfaces.
FILLET SEAL	A primary seal applied along the edges of faying surfaces and over, along and between installed parts.
FIRE SAFE	An atmospheric concentration of combustible vapors equal to or less than 20% LEL or (1200 ppm).
FIRST FILLET (UNDERSIZE FILLET)	The first small bead or undersize fillet of curing type sealant applied to a surface.
FIT JIG	A structure built to duplicate a fuel cell cavity. Used to ensure cell fitting locations and hangars are correctly positioned.
FRIED or SCARRED CONDITION	Depressed areas in fuel cell liner, caused by air or solvent vapor trapped between the liner material and building form.
FUEL CELL	A flexible bag contoured to the shape of a fuselage or wing cavity and designed to contain a liquid. Three basic types of cells are bladder, self-sealing and a combination.
ACTIVATION	A condition which occurs in self-sealing cells when fuel contacts the sealant causing the sealant to swell.
BAFFLE SHOES	Fabric straps attached to the liner of a cell to secure the internal baffles to cell walls.
FITTING	Attaching points of a fuel cell for functional equipment such as pumps, vents or outlets.
HANGAR SUPPORT	An exterior attachment to a fuel cell, usually made of loop of webbing, used to attach fuel cell to aircraft structure for support.

HANGAR STRAP	An exterior attachment to a fuel cell, usually made of loop of webbing, used to support a fuel cell installed in aircraft and storage containers.
INNER LINING	First ply of fuel cell material, functions as a support and protects nylon barrier. May be constructed of fabric or rubber.
SELF SEALING	A cell designed to automatically seal itself when punctured.
SELF SUPPORTING	A cell designed to support itself without support from surrounding structures.
SEPARATIONS	Areas of non-adhesion between cell plies but exhibit no evidence of trapped liquid.
FUEL LEAKS	Refer to T.O. 00-25-172 for more information on Class 1, 2, and 3 leaks.
CLASS 1	Involve an area less than two feet in any direction.
CLASS 2	Involve an area not over 10 feet in any direction, or not over 50 square feet.
CLASS 3	Involve an area over 10 feet in any direction, or over 50 square feet.
FULL-BODIED FILLET	A bead of curing-type sealant conforming to final required dimensions of fillet seal.

G

GROOVE SEAL	See INJECTION SEAL.
GROUNDING	The removal of a static electrical charge from the surface of an object by connecting the object to an approved ground.

I

IDLH	Immediately Dangerous to Life and Health, any condition which poses immediate threat to life or may result in acute severe health effects.
INERTING	The replacement of oxygen in the atmosphere with a gas to the point the atmosphere will not support combustion or explosion.
INJECTION SEAL	A seal accomplished by injecting a curing type or non-curing type sealant into holes, channels and other voids in fuel tank boundaries.
INTEGRAL FUEL TANK	Any cavity designed to hold fuel or other liquid.
INTERFERENCE SEAL (FASTENER)	A seal produced by metal-to-metal contact between a fastener and its mating hole.
INTRINSICALLY SAFE	Equipment and wiring that is not capable of producing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a flammable or combustible atmospheric mixture in its most easily ignitable concentration.
ISOLATION SEAL	A repair seal composed of structure, fasteners, and sealing materials which reestablishes seal continuity and are in immediate contact with the fuel being contained. A short seal installed on some tanks to isolate potential leakage, such as channeling of fuel along a leak path between structural members.

L

LAP SEAM	A seam made by placing the flat edge of one piece of material over the edge of a second piece of material or over itself.
LEAK PATH	The path or trail leaking fuel follows from the leak source to the leak exit point.
LEAK SOURCE	The place inside the tank where the leak originates.
LEAK EXIT	The point outside of a tank where a leak first appears.
LEL	Lower Explosive Limit is the lowest concentration of flammable or combustible vapors which can be ignited by a spark or flame.

M

MASTER ENTRY PERMIT	A letter issued by the Logistics Group Commander (with coordination from Ground Safety, Bioenviromental Engineering Services, and the Fire Department) qualifying the Entry Authority and Designated Alternate Entry Authority and the conditions under which the Entry Permit may be issue.
MECHANICAL SEAL	A seal produced by deformation of an elastic material due to interference at the contacting surfaces as in access doors or O-rings.

MSDS	Material Safety Data Sheet. Supplied by manufacturers to inform customers of hazards associated with their product.

N

NFPA CODES	National Fire Protection Association Codes. A list of accepted practices to prevent fires. In general the Air Force accepts most of the codes.

O

OFF-PRESSURE SEAL	A level of sealant applied outside of the seal plane.
OSHA-STD	Occupational Safety and Health Standards. The federal law covering worker and workplace safety/health.

P

PARTING AGENT	A material used to prevent sealant from sticking to a surface.
PERMANENT REPAIR	A repair which returns a tank to a no leak condition.
PERMIT REQUIRED CONFINED SPACE	All integral tanks and fuel cells capable of being entered.
PLASTICIZER	An additive in rubber or plastic to increase the pliability or low temperature flexibility of the finished product.
PPE	Personal Protective Equipment. Refer to AFOSH 91-31.
PLY	A layer of basic fuel cell construction, either fabric or non-fabric.
POSTASSEMBLY SEAL	A seal that has been applied after the tank structure has been assembled. (See FILLET SEAL and INJECTION SEAL).
PRECOAT SEAL	The application of a coat of brushable sealant to serve as a base for fillet seal (see BRUSHCOAT).
PREPACK SEAL	A seal applied during tank assembly by packing inside and areas which are not readily accessible without disassembly with a curing type sealant.
PRIMARY SEAL	A seal which by itself, can contain fuel and requires no additional seals (see ABSOLUTE SEAL).
PURGE	A process which removes flammable or combustible fluids and vapors.

R

REDUNDANT SEAL	The use of two primary sealing systems, or seals in which one acts as a backup for the other.
RESCUE TEAM	A group of two or more specially trained employees (preferable fuel system repair specialist (AFSC 2A6X4 or equal)) who are designated to rescue entrants from confined spaces.

S

SCOTCHWELD SEAL	A General Dynamics sealing system design using AF-10 structural adhesive.
SEALANT, CURING TYPE	A multiple part sealant which changes, after mixing, from a soft state to a rubber-like tack-free condition.
SEALANT, NON-CURING TYPE	A sealing material that does not cure with time, retaining its original semi-liquid condition. Commonly used in channel grooves.
SEALING GROOVE	Grooves machined in the faying surface of a fuel tank boundary for injection sealant.
SEAL PLANE	All surfaces of a tank which establish fuel seal continuity and are in immediate contact with fuel.
SECONDARY SEAL	A seal which by itself will not constitute a reliable primary seal.
SELF-SEALING FASTENER	A fasteners which provides a fuel tight seal without the application of sealant.
STATIC ELECTRICITY	The accumulation of an electrical charge on a person or object due to friction, wind or induction.

T

TACK-FREE	The condition of a sealant during the curing stage when the sealant will not stick to polyethylene plastic when pressed lightly to the surface.
TASK	Any designated work, e.g. inspection, repair, etc.
TEMPORARY REPAIR	A repair designed to down grade leak classifications to a flyable condition until such time as a permanent repair is applied.
TOP COAT	A material applied over the fuel exposed surfaces of some curing type sealants to protect the sealant from deterioration.

V

VENTILATION	The process of supplying air to a tank or cell after a fluid purge.
VOID SEAL	A seal used to fill holes, joggles, channel, and other voids caused by the buildup of structure in a fuel tank; and which provides continuity of sealing where fillet seals are interrupted by these structural gaps.
VOID	Any opening, small crack or crevice occurring at the juncture of structural members.

W

WET INSTALLED FASTENER	A fastener which is coated on the shank and under the head with a curing type sealant to provide a corrosion barrier and a secondary seal.
WETTED SURFACE	Any surface which is in direct contact with fuel.